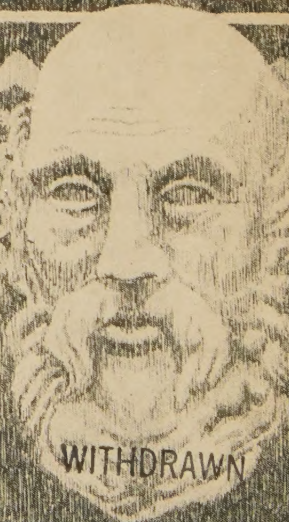


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ESSENTIALS
OF
CHEMISTRY
AND
TOXICOLOGY

FOR THE USE OF STUDENTS IN MEDICINE

BY

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TWELFTH EDITION

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PREFACE TO THE FIRST EDITION.

THIS little volume is designed to fill a vacancy hitherto left unoccupied by chemical writers. Many valuable text-books have appeared within the past few years ; none of these, so far as I am aware, are designed for, or adapted to the special needs of, the American medical student, and all are more or less overburdened with descriptions of technical and pharmaceutical processes which are of no direct importance to the practitioner in medicine. In the following pages I have omitted all topics which are not "essential" to an understanding of those chemical problems which have a direct bearing upon the practice of medicine ; more attention has been directed to the chemistry of therapeutics than to that of pharmacy, while physiological chemistry, which must now be

regarded as one of the most important foundations of rational medicine, has been treated of as fully as the limits of the volume will permit.

The modern system of notation has been adopted, and the principles of the atomic theory have been dealt with in such a manner as, it is hoped, will afford the student a firm groundwork for future study.

It has not been my intention to write a manual of analytical chemistry, as those already at the command of the student leave nothing to be desired ; I have, therefore, given only such analytical processes as the physician may reasonably expect to make use of in the course of his daily practice.

Weights and measures are given in the metric system, and temperatures in degrees of the Centigrade scale.

R. A. W.

New York, Oct., 1878.

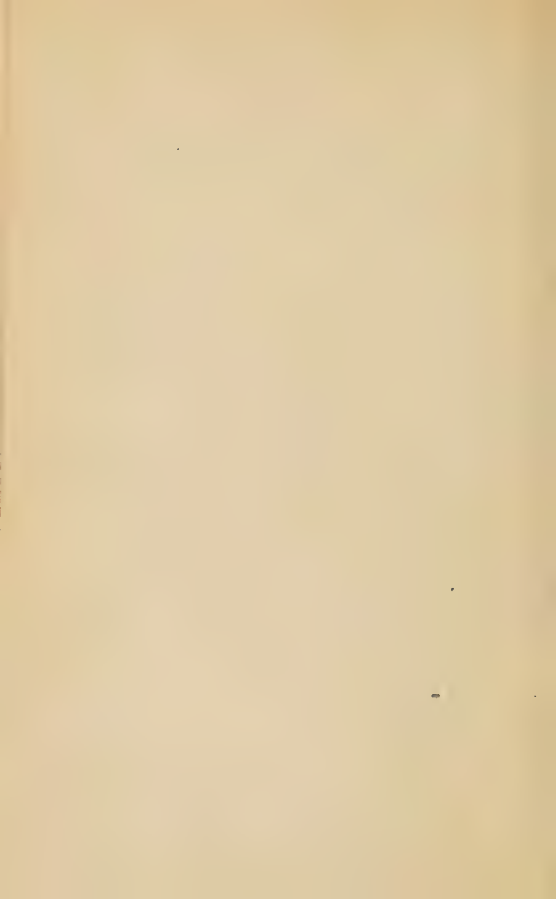
PREFACE TO THE PRESENT EDITION.

IN the present edition the part relating to the compounds of carbon has been in great part rewritten and rearranged to keep pace with the advances in organic chemistry, so far as is possible in a work of this character. Many of the alkaloids have been removed from the "miscellaneous" class to their proper positions in the classification, and brief notice is taken of the ptomaines and of advances in physiological chemistry.

In this edition, also, the orthography adopted by the American Association for the Advancement of Science has been followed.

R. A. W.

New York, Sept. 19, 1894.



ESSENTIALS OF CHEMISTRY

AND

TOXICOLOGY.

INTRODUCTION.

1. *How do physical and chemical phenomena differ from each other?*

In the former the composition of the matter acted on remains unchanged, while in the latter it is altered. Thus, when a cylinder of lime is strongly heated it becomes white hot and emits light; it is still lime, however, after the action of the heat, as it was before. This is a physical phenomenon. If now we throw this lime into hydrochloric acid it disappears, and, after the action has been completed, we find neither lime nor hydrochloric acid, but two new substances, one a solid, called calcium chlorid, the other a liquid—water; both of which differ in their composition from the original substances, which have disappeared. This is a chemical phenomenon.

2. *What is chemistry?*

It is that branch of science which treats of the composition of substances, their changes in composition, and the laws governing such changes.

3. *How may we classify all matter?*

Into elements and compounds.

4. *What is an element?*

A kind of substance which we cannot, by any known means, split up into any two or more other kinds of substance; as iron, charcoal, oxygen. Elements are also called elementary or simple substances.

5. *What is a compound?*

A substance made up of two or more elements in definite proportions; as water, sulfuric acid, potash.

6. *How many elements are now known?*

Sixty-nine. See Appendix A.

7. *What is an atom?*

The smallest quantity of an elementary substance that can enter into chemical action.

It is, therefore, improper to speak of an atom of a compound substance.

8. *What is a molecule?*

The smallest quantity of any substance that can exist in a free state. Molecules nearly always contain two or more atoms. In molecules of elementary bodies the atoms are of the same kind, while in compound substances they are of different kinds. The molecule of hydrogen is made up of two atoms of hydrogen, while the molecule of hydrochloric acid is made up of one atom of hydrogen united with one atom of chlorine.

9. *State the law of definite proportions.*

The relative weights of elementary substances contained in a compound are definite and invariable, *e.g.*, water contains 2 parts by weight of

hydrogen and 16 parts of oxygen, never more and never less.

10. *State the law of multiple proportions.*

When two elements unite with each other to form more than one compound, the resulting compounds contain simple multiple proportions of one element as compared with a constant quantity of the other; *e.g.*, nitrogen and oxygen unite with each other to form five compounds, in which, for 28 parts by weight of nitrogen, there are contained 16 parts by weight of oxygen, or some simple multiple of 16:

Nitrogen monoxid contains 28 pt's nitrogen & 16 oxygen.					
"	dioxid	"	28	"	" 16×2=32 "
"	trioxid	"	28	"	" 16×3=48 "
"	tetroxid	"	28	"	" 16×4=64 "
"	pentoxid	"	28	"	" 16×5=80 "

11. *What is a compound?*

A substance made up of two or more elements, united with each other in definite proportions.

The properties of a compound are properties of its own and independent of those of the constituent elements. Thus, the properties of water are entirely different from those of the constituent gases, oxygen and hydrogen.

To separate the elements of a compound a chemical decomposition is necessary.

12. *What is meant by "analysis" and "synthesis"?*

Analysis is the decomposition of a compound into simpler compounds or into elements.

Synthesis is the formation of compounds from elements or from simpler compounds.

13. *What is a "mixture"?*

A product obtained by uniting into a more or less homogeneous whole two or more substances, whether elementary or compound.

The properties of a mixture are an aggregation of the properties of its constituents.

The substances composing a mixture may frequently be separated from each other by simple, physical means.

E. g. A mixture of sugar and chalk is sweet; the sugar remains soluble in water and may be separated from the insoluble chalk by washing with water. The chalk and sugar are each capable of the same chemical actions while in the mixture as when free.

14. *State the law of reciprocal proportions.*

The ponderable quantities in which substances unite with the same substance express the relation, or a simple multiple thereof, in which they unite with each other.

E. g. Forty parts of calcium combine with 71 parts of chlorin, and 40 parts of calcium combine with 16 parts of oxygen, therefore 71 parts of chlorin combine with 16 parts of oxygen, or the combination occurs in the proportions of some simple multiples of 71 and 16.

15. *State the laws of Gay Lussac.*

1. There exists a simple relation between the volumes of gases which combine with each other.

2. There exists a simple relation between the sum of the volumes of the constituent gases and the volume of the gas formed by their union.

1 vol. chlorin + 1 vol. hydrogen = 2 vols. hydrochloric acid.

1 vol. oxygen + 2 vols. hydrogen = 2 vols. vapor of water.

1 vol. nitrogen + 3 vols. hydrogen = 2 vols. ammonia.

16. *State the law of Avogadro.*

Equal volumes of all gases, under like conditions of temperature and pressure, contain equal numbers of molecules.

This is also known as the law of Ampère.

17. *By the preceding laws and the results of experiment prove that, if the atom of hydrogen weighs one, that of oxygen weighs sixteen, and that of chlorine thirty-five and a half.*

It may be shown by experiment that hydrogen combines with chlorine and oxygen in the following proportions by volume :

1 vol. chlorine + 1 vol. hydrogen = 2 vols. hydrochloric acid.

1 vol. oxygen + 2 vols. hydrogen = 2 vols. water vapor.

If equal volumes contain equal numbers of molecules,

1 molecule chlorine + 1 molecule hydrogen = 2 molecules hydrochloric acid.

1 molecule oxygen + 2 molecules hydrogen = 2 molecules water.

As each molecule of hydrochloric acid contains chlorine and hydrogen, the molecules of chlorine and hydrogen must each contain two quantities smaller than the molecules, *i.e.*, two atoms. Therefore

2 atoms chlorine + 2 atoms hydrogen = 2 molecules hydrochloric acid.

2 atoms oxygen + 4 atoms hydrogen = 2 molecules water.

But the relations by weight in which the combinations occur are :

35.5 chlorin + 1 hydrogen = 36.5 hydrochloric acid.

16 oxygen + 2 hydrogen = 18 water.

Therefore, if one atom of hydrogen weighs 1, an atom of chlorin weighs 35.5 and an atom of oxygen weighs 16.

18. *What is the atomic weight of an element?*

The weight of one of its atoms as compared with the weight of an atom of hydrogen. Thus, an atom of hydrogen weighing 1, an atom of oxygen weighs 16, an atom of sulfur 32, and an atom of chlorin 35.5. This weight is relative and not absolute. What the absolute weight of an atom of hydrogen may be we do not know.

19. *What is molecular weight?*

The weight of the molecule of any substance, simple or compound, in terms of the weight of one atom of hydrogen. Thus, the molecule of hydrogen being composed of two atoms of hydrogen, its molecular weight is 2. The molecular weight of hydrochloric acid is 36.5, its molecule being 36.5 times as heavy as an atom of hydrogen.

The molecular weight of a substance may also be said to be the sum of the weights of the atoms composing its molecule. Thus the molecule of hydrochloric acid contains one atom of hydrogen, weighing 1, and one atom of chlorin, weighing 35.5, therefore its molecular weight is 36.5.

20. *How is Avogadro's law utilized in the determination of molecular weights?*

The specific gravity of a gas (hydrogen = 1) is

the weight of a given volume of the gas compared with the weight of an equal volume of hydrogen. It is therefore, under Avogadro's law, also the weight of a molecule of the gas as compared with the weight of a molecule of hydrogen; and as the unit of molecular weights is the atom, or half molecule of hydrogen, the molecular weight of the gas or vapor is its specific gravity (hydrogen = 1) multiplied by two.

21. *What is the "valence" of an element?*

The combining power of one of its atoms as compared with that of hydrogen.

Atoms of certain elements, such as chlorin, are found to be equal in combining power to those of hydrogen, *i.e.*, one atom of chlorin is equal to one atom of hydrogen; such elements are said to be *univalent*. Atoms of other elements, as oxygen, are found to be equal in combining power to two atoms of hydrogen; these are said to be *bivalent*. So other elements are said to be *trivalent*, *quadrivalent*, *quinquivalent*, *sexivalent*, as their atoms are equal in combining power to three, four, five, or six atoms of hydrogen.

The valence of an element is expressed symbolically thus: ' univalent, " bivalent, "' trivalent, ^{iv} quadrivalent, ^v quinquivalent, and ^{vi} sexivalent, the sign being placed over and to the right of the symbol of the element, thus: O'', P^v. (See Q. 23.)

Elements are also classified as *monads*, *diads*, *triads*, *tetrads*, *pentads*, according as their valence is equal to one, two, three, four, or five.

22. *What are artiads and perissads?*

Artiads are elements of even valence; *perissads* those of uneven valence.

23. *What are chemical symbols?*

Signs by which the elementary substances are expressed in chemical writing. The symbol of an element is the first (capital) letter of its Latin name, usually followed by one of the small letters; thus the symbol of hydrogen is H, that of chlorin Cl, and that of carbon C.

24. *Does the symbol express a definite or an indefinite quantity of the element?*

A very definite quantity, namely, one atom.

25. *What is a formula?*

A collection of symbols representing a molecule and expressing the number and kinds of atoms of which it is constituted; thus HCl is the formula of hydrochloric acid, and expresses that its molecule is composed of one atom of hydrogen and one atom of chlorin; H₂O is the formula of water, and shows that its molecule is composed of two atoms of hydrogen and one atom of oxygen.

26. *What is a chemical equation?*

An expression, by means of symbols, numbers, and signs, of a chemical action. The sign + is used as the equivalent of the word "and," and the sign = indicates that the substances whose formulæ are placed before it have acted upon each other (have "reacted") to produce the substances whose formulæ follow the sign. Thus, the equation,



indicates that one molecule, composed of one atom of calcium and one atom of oxygen, and two molecules, each composed of one atom of hydrogen and one atom of chlorin, have acted

upon each other. This action has produced one molecule, composed of one atom of calcium and two atoms of chlorine, and one molecule, composed of two atoms of hydrogen and one atom of oxygen.

As matter cannot be lost or created, the same number of each kind of atom must occur before and after the $=$ sign.

27. *What is an acid?*

(1) It is a compound of an electro-negative element or radical with hydrogen, which hydrogen it can part with in exchange for an electro-positive element, without formation of a base. (See Q. 32.)

(2) It is a compound which evolves water by its action upon pure caustic potash, or soda.

28. *What is the basicity of an acid?*

It is the number of replaceable atoms of hydrogen contained in its molecule.

Thus, HNO_3 is *monobasic*, H_2SO_4 is *dibasic*, H_3PO_4 is *tribasic*.

Polybasic acids are those whose basicity is greater than one.

29. *What are hydracids and oxyacids?*

A hydracid is one containing no oxygen; as HCl . An oxyacid is one containing oxygen; as H_2SO_4 .

30. *What is a salt?*

It is an acid whose hydrogen has been partially or completely replaced by an electro-positive element or elements (a metal or metals). (See Q. 33.)

31. *What are haloid salts; what oxyacids?*

A haloid salt is a salt of a hydracid. An oxy-salt is a salt of an oxyacid.

32. *What is a base?*

It is a substance which will react with an acid to produce a salt and water.

33. *What is a metal?*

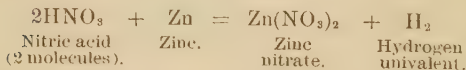
An element capable of replacing the hydrogen of an oxyacid to form a salt. (See Classification of Elements, p. 16.)

34. *How many salts of an univalent metal and a monobasic acid can exist?*

Only one. One atom of the metal is capable of replacing one atom of hydrogen, and the acid only contains one atom of H capable of being so replaced; *e.g.*, the only possible salt of sodium and nitric acid is sodium nitrate, NaNO_3 .

35. *How are the salts of the monobasic acids with bivalent metals formed?*

An atom of the bivalent metal displacing two atoms of hydrogen, and the monobasic acids only containing one atom of replaceable hydrogen in each molecule, the formation of salts by these two substances is only possible when two molecules of the acid combine and the atom of bivalent metal replaces their united hydrogen, thus:

36. *How many salts may be formed by an univalent metal and a dibasic acid?*

Two. One in which only one of the atoms of hydrogen has been replaced by an atom of the metal, *e.g.*, HNaSO_4 ; and another in which both

atoms of hydrogen have been replaced by atoms of the metal, *e.g.*, Na_2SO_4 .

37. *What is understood by the reaction of a substance?*

All the acids and some salts have the power of reddening certain vegetable blue colors, such as solution of litmus; these are said to have an acid reaction. Certain other substances, as the hydroxids of sodium and potassium, have the power of restoring the blue color of litmus after it has been reddened by an acid; these substances are said to be alkaline in reaction. When a substance will neither redden litmus nor restore its blue color when reddened, it is said to be neutral.

38. *What is meant by "neutralization"?*

The addition of an acid to a base (or *vice versa*) in such quantity that they are both converted entirely into salt.

The reaction changes from acid or alkaline to neutral, except when the salt formed itself has an acid or alkaline reaction.

39. *The formula of hydrochloric acid being HCl and that of caustic soda NaHO , and the atomic weights being: $\text{H} = 1$; $\text{Cl} = 35.5$; $\text{Na} = 23$; $\text{O} = 16$, how much caustic soda is required to neutralize 36.5 parts of hydrochloric acid? and what are the formulæ and quantities of the products?*

The reaction takes place according to the equation:



The molecular weight of hydrochloric acid is

$1 + 35.5 = 36.5$; that of caustic soda is $23 + 1 + 16 = 40$. Therefore 40 parts of NaHO are required to neutralize 36.5 parts of HCl. The products are : NaCl, $23 + 35.5 = 58.5$; and H_2O , $2 + 16 = 18$. As $36.5 + 40 = 76.5$ equals $58.5 + 18 = 76.5$, the work is correct. (See Q. 489, 490.)

NOTE.—The student should be frequently practised in writing equations, and should be called upon from time to time to make calculations such as the above, and later to take into account water of crystallization, purity, etc. See *Stoichiometry*, in Manual, 4th Ed., pp. 44-46.

40. *How are compounds containing two, three, or four elements distinguished by name?*

A compound whose molecule contains two elements is called a *binary* compound, e.g., H_2O ; one containing three elements is called a *ternary* compound, e.g., H_2SO_4 ; and one containing four elements is called a *quaternary* compound, e.g., $KHSO_4$.

41. *What is the fundamental principle of modern chemical nomenclature?*

That the name shall indicate, so far as possible, the composition and constitution of the substance.

By *composition* we understand the kinds of elements of which the molecule of the compound is composed, and the number of atoms of each kind. By *constitution* we understand the relations which the several atoms constituting the molecule bear to each other. (See Q. 692.)

42. *How are the names of binary substances constructed?*

They are made up of the name of the more

electro-positive, followed by the name of the more electro-negative, in which the termination *in*, *on*, *ogen*, *ygen*, *orus*, *ium*, or *ur* is changed to *id*; *e.g.*, the compound of potassium and chlorin is called potassium chlorid; that of calcium and oxygen, calcium oxid; and that of sodium and sulfur, sodium sulfid.

43. *When more than one binary compound of the same two elements exist, how are they distinguished by name?*

By prefixing to either word of the name, constructed as in No. 42, the Greek numeral corresponding to the number of atoms of the element designated by that word, as compared with a *fixed* number of atoms of the other element :

N_2O = Nitrogen *monoxid*.

$\text{NO}(=\text{N}_2\text{O}_2)$ = Nitrogen *dioxid*.

N_2O_3 = Nitrogen *trioxid*.

$\text{NO}_2(=\text{N}_2\text{O}_4)$ = Nitrogen *tetroxid*.

N_2O_5 = Nitrogen *pentoxid*.

44. *How are the names of the oxyacids constructed?*

By writing the word *acid*, preceded by the name of the electro-negative element other than oxygen, in which the termination is modified, and to which a prefix is sometimes added to indicate the degree of oxidation.

When but two acids exist, that containing the least amount of oxygen is designated by the termination *ous*; that containing the greater amount of oxygen, by the termination *ic*—*e.g.*:

HNO_2 = Nitrous acid.

HNO_3 = Nitric acid.

When more than two acids are known, that containing less oxygen than the *ous* acid is designated by the prefix *hypo*; that containing more oxygen than the *ic* acid, by the prefix *per*—e.g.:

HClO = *Hypochlorous acid*.

HClO_2 = *Chlorous acid*.

HClO_3 = *Chloric acid*.

HClO_4 = *Perchloric acid*.

In the cases of the acids of sulfur and of phosphorus (q. v.), derived acids exist, which are differently named.

45. *How are the names of oxysalts derived from those of the corresponding acids when the valence of the metal equals the basicity of the acid?*

By prefixing to the name of the acid that of the metal, changing the termination *ous* into *ite*, or *ic* into *ate*, and expunging the word *acid*:

HNO_2
Nitrous acid.

$\text{K}'\text{NO}_2$
Potassium nitrite.

H_2SO_4
Sulfuric acid.

$\text{Ca}''\text{SO}_4$
Calcium sulfate.

The salts of the hydracids, being binary compounds, are named in accordance with No. 42:

HCl
Hydrochloric acid.

KCl
Potassium chlorid.

46. *How are the names of oxysalts derived from those of the acids when the valence of the metal and the basicity of the acid are unequal?*

In the same way as in No. 45, except that the Greek numeral corresponding to the number of

atoms of the metal in the salt is prefixed to the name of the metal, whose termination is also changed to *ic*:



Phosphoric acid.



Monopotassic phosphate.



Dipotassic phosphate.



Tripotassic phosphate.

For rules governing chemical orthography and pronunciation, see Manual, Appendix A, pp. 511-515.

CLASSIFICATION OF THE ELEMENTS.

CLASS I. TYPICAL ELEMENTS.

Hydrogen—Oxygen.

CLASS II. ACIDULOUS ELEMENTS.

Elements whose oxids combine with water to form acids, never to form bases. Which do not displace the hydrogen of oxyacids to form oxysalts.

GROUP I. Fluorin, chlorin, bromin, iodin.

GROUP II. Sulfur, selenium, tellurium.

GROUP III. Nitrogen, phosphorus, arsenic, antimony.

GROUP IV. Boron.

GROUP V. Carbon, silicon.

GROUP VI. Vanadium, columbium, tantalum.

GROUP VII. Molybdenum, tungsten, osmium (?).

CLASS III. AMPHOTERIC ELEMENTS.

Elements whose oxids unite with water, some to form acids, others to form bases. Which form oxysalts.

GROUP I. Gold.

GROUP II. Chromium, manganese, iron.

GROUP III. Glucinium, aluminium, scandium, gallium, indium.

GROUP IV. Uranium.

GROUP V. Lead.

GROUP VI. Bismuth.

GROUP VII. Titanium, germanium, zirconium, tin.

GROUP VIII. Palladium, platinum.

GROUP IX. Rhodium, ruthenium, iridium.

CLASS IV. BASYLOUS ELEMENTS.

Elements whose oxids unite with water to form bases, never to form acids. Which form oxysalts.

GROUP I. Lithium, sodium, potassium, rubidium, cæsium, silver.

GROUP II. Thallium.

GROUP III. Calcium, strontium, barium.

GROUP IV. Magnesium, zinc, cadmium.

GROUP V. Nickel, cobalt.

GROUP VI. Copper, mercury.

GROUP VII. Yttrium, cerium, ytterbium, lanthanum, didymium, erbium, samarium.

GROUP VIII. Thorium.

See Manual, 4th ed., pp. 52-54.

CLASS I. TYPICAL ELEMENTS.

HYDROGEN. H'. 1.

47. *What are the symbol, valence, atomic and molecular weights of hydrogen?*

Its symbol is H. It is univalent. The weight of one atom of hydrogen is the unit of atomic weights, the standard with which the atoms are compared. Its atomic weight is therefore 1. Its molecular weight is 2.

48. *How does H exist in nature?*

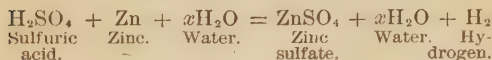
Free in volcanic gases, in fire damp, in meteorites, in the gases exhaled from the lungs, and in those of the stomach and intestines. In combination, in water, hydrogen sulfid, ammoniacal compounds, and in many organic substances.

49. *How is it prepared?*

By the decomposition of water (which is a compound of hydrogen and oxygen). Either:
1. By the action of a galvanic current. 2. By certain metals having a great tendency to unite with oxygen, as sodium. 3. By the action of hot zinc or iron. 4. By the action of these metals (zinc or iron) on cold, dilute sulfuric or hydrochloric acid. The last is the method which is usually resorted to. When obtained by this process, H is almost always contaminated with small quantities of other gases, due to the pre-

sence of impurities in the zinc and acid used. When perfectly pure H is required it is better to resort to the decomposition of water by the battery. See Manual, pp. 55-57.

50. *Write the equation representing the action between zinc and sulfuric acid.*



51. *State some of the principal physical properties of hydrogen.*

A gas, colorless, odorless, and tasteless. It is the lightest known substance, being about $14\frac{1}{2}$ times lighter than air. One litre of hydrogen weighs, at 0°C . and 760 mm. barometric pressure, Grm. 0.0896. It is exceedingly diffusible. At -140° (-229°Fah.) and 650 atmospheres pressure it forms a steel-blue liquid. Its solubility in water is small, but is the same at all temperatures.

52. *What results when a flame is applied to pure hydrogen?*

The gas ignites, and burns with a pale blue flame, producing little light, but much heat.

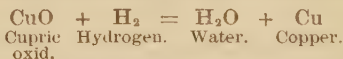
The product of the burning is water = H_2O .

53. *Is it a supporter of combustion or respiration?*

No. A taper introduced into a vessel of H is extinguished, the hydrogen itself burning at the mouth of the vessel. An animal introduced into an atmosphere of pure hydrogen dies, not from any active agency of the gas, but from lack of oxygen.

54. *Explain what takes place when certain oxids, as those of iron or copper, are heated in hydrogen.*

At elevated temperatures the oxygen has a greater tendency to unite with hydrogen than to remain combined with the other element, consequently the oxid is decomposed, water is formed and passes off as steam, while the metal remains.



Such an action is called a *deoxygenation* or a *reduction*, and any substance which, like hydrogen, has a tendency thus to remove oxygen from its compounds is said to be a *deoxygenizing* or *reducing* agent.

OXYGEN. O''. 16.

55. *What are the symbol, valence, and atomic and molecular weights of oxygen?*

O. Bivalent. Atomic weight = 16. Molecular weight = 32.

56. *How does O exist in nature?*

It is the most abundant of the elements. Exists free in atmospheric air, and in combination in a great number of substances.

57. *How is it prepared?*

By decomposing a compound rich in oxygen. Potassium chlorate is generally decomposed by heat, when oxygen is given off and potassium chlorid remains. The chlorate is heated in a retort of difficultly fusible glass, or preferably of metal, which should not be more than a third

or half full ; the gas is collected over water. By mixing with the chlorate an equal weight of manganese dioxid the liberation of oxygen takes place at a lower temperature. When this mixture is used, care must be had that the manganese compound has not been adulterated, and that no organic matter is present, lest an explosion occur. The gas produced from this mixture must be washed by causing it to bubble through a solution of potash to separate a small quantity of chlorin which is formed. This precaution is essential if the gas is to be used for inhalation.

Oxygen is also prepared :

1. By the electrolysis of water. 2. By heating certain oxids and peroxids. 3. By the action of sulfuric acid on compounds rich in O. 4. By the mutual decomposition of potassium permanganate and hydrogen peroxid, etc.

58. *State the more prominent physical properties of O.*

It is a colorless, odorless, tasteless gas ; heavier than air (sp. gr. 1.108, air = 1). Sparingly soluble in water ; more readily soluble in absolute alcohol. It liquefies at -140° (-229° F.) under a pressure of 300 atmospheres. The liquid boils at $-187^{\circ}.4$ ($-294^{\circ}.5$ F.),

59. *Does O unite readily with other elements?*

Very readily, and compounds of oxygen with all other elements except fluorin are known.

60. *What is a compound of O with another element called?*

An oxid.

61. *What is meant by oxidation and combustion?*

By oxidation we mean the act of union of oxy-

gen with another element. This process is attended by the liberation of heat, and, when it takes place rapidly, of light. The rusting of a given weight of iron is a slow oxidation, while the burning of the same in oxygen is a rapid oxidation. Only the latter produces light, while in both cases the same amount of heat is liberated. By combustion, in a general sense, is meant the rapid union of the oxygen of the air with some other substance, as coal or phosphorus. In a wider sense, however, combustion may be defined as any chemical union of two substances attended by liberation of heat and light.

62. *What are meant by combustibles and supporters of combustion?*

By a combustible we understand a substance having a great tendency to unite rapidly with oxygen, such as phosphorus and sulfur. Such substances burn with greater brilliancy in pure oxygen than in air, which is oxygen in a diluted form. By supporters of combustion we mean gases with which substances of the last class enter into chemical action attended by light and heat.

63. *Is the distinction in the last section a scientific one?*

No. The process of combustion being a union of two substances, each of these takes an equal part in the reaction. The air or oxygen burns quite as much as the jet of illuminating gas which we say burns; indeed, we may light a jet of oxygen in an atmosphere of coal gas, when it will burn as would a jet of coal gas in an atmosphere of oxygen.

64. *When we burn a candle, what takes place, and how does the sum of the weights of the products compare with that of the candle?*

The substance of the candle is made up principally of two elements, carbon and hydrogen; which, uniting with the oxygen of the air, form compounds called carbonic anhydrid and water. The former is an invisible gas and the latter passes off as steam. If, by a suitable arrangement, we collect and weigh these products of the combustion, we find that their united weight is greater than that of the candle, and this increase in weight is equal to the weight of the oxygen which has been abstracted from the air and united to the carbon and hydrogen.

65. *Of what importance is oxygen in respiration?*

It is the only substance capable of maintaining the process for any length of time, and will only do so when suitably diluted with an inert gas, such as nitrogen. The principal purpose of respiration is to furnish oxygen for the oxidations occurring in the body. The blood in the lungs gives off carbonic anhydrid, which results from the oxidation of carbon, and water, which results from the oxidation of hydrogen. At the same time it removes oxygen from the air. This oxygen is then carried to the various tissues, composed largely of carbon and hydrogen. Oxidation takes place here, with the production of carbonic anhydrid and water, while heat is liberated.

66. *What is an "anhydrid"?*

An oxid capable of combining with water to form an acid. Thus, SO_3 is called sulfuric anhy-

drid because : $\text{SO}_3 + \text{H}_2\text{O} = \text{H}_2\text{SO}_4 =$ sulfuric acid.

67. *What are "basic oxids" ?*

Oxids which combine with water to form bases. Thus, quicklime is a basic oxid, because it combines with water to form the base CaH_2O_2 .

68. *What are "neutral, saline, or indifferent oxids" ?*

Oxids which are either essentially neutral, as water ; or are formed by the union of two other oxids, as the red oxid of lead, Pb_3O_4 , which is a union of $2(\text{PbO})$ and PbO_2 .

69. *What is ozone ?*

Oxygen in a peculiar condition of condensation. The molecule of oxygen is made up of two atoms, while that of ozone contains three.

70. *Under what conditions is ozone formed, and to what extent ?*

Pure liquid ozone has been obtained by subjecting ozonized oxygen to the temperature of liquid oxygen at the atmospheric pressure.

In diluted form it is prepared by passing silent electric discharges through cold, dry air or oxygen ; by the action of concentrated sulfuric acid on barium dioxid ; by slow oxidation of phosphorus in damp air ; by the decomposition of water by the battery.

The first-mentioned method gives the best yield, which, under most favorable conditions, does not contain more than ten per cent. of ozone.

71. *What are the properties of ozone ?*

The pure liquid is dark blue, almost opaque, and evaporates to a bluish gas.

In the dilute form it is slowly converted into

ordinary oxygen in the presence of water at 100° (212° F.), a change which takes place rapidly at 237° (459° F.). It is a powerful oxidant.

72. *Describe the tests for ozone.*

1. Neutral litmus paper, impregnated with solution of potassium iodid, is turned blue by ozone. The same paper, without iodid, is not affected.

2. Paper impregnated with a solution of a thalious salt is turned brown.

3. Metallic silver is blackened by it.

COMPOUNDS OF HYDROGEN AND OXYGEN.

73. *How many compounds of hydrogen and oxygen are known, and what are they?*

Two :

Hydrogen monoxid, or water, H_2O

“ dioxid or peroxid, H_2O_2

74. *Describe the physical properties of water.*

Below 0° (32° F.), it is a crystalline solid (ice, snow). Above that temperature and below 100° (212° F.), at a barometric pressure of 760 mm., it is a liquid which boils at the temperature named. Its boiling point is elevated by increased pressure, and falls with diminished pressure. Its vapor is colorless and transparent. It is an excellent solvent.

75. *In what way is the solubility of solids in water affected by variations in temperature?*

As a rule, the amount of a solid which a given volume can dissolve increases as the temperature is raised.

There are exceptions. Thus, common salt is nearly equally soluble at all temperatures. The solubility of disodic sulfate increases rapidly up to 33° (91°.4 F.), and then diminishes nearly as rapidly at higher temperatures. A few solids, like the hydroxid and citrate of calcium, are more soluble at low than at high temperatures.

76. *How is the solubility of gases in water influenced by variations in temperature and pressure?*

All gases (except hydrogen) are the more soluble the lower the temperature and the greater the pressure.

77. *What is a saturated solution?*

One containing as much of the dissolved substance as can be dissolved at the existing temperature and pressure.

78. *Explain what is understood by physical and what by chemical solution.*

In a physical solution there is no modification of the solvent or substance dissolved. Such a solution, on evaporation, deposits the dissolved solid unaltered.

In chemical solution, the solvent and dissolved substance act upon each other to produce a new substance, which is then dissolved. Such a solution does not leave the substance originally dissolved when it is evaporated.

79. *What is water of crystallization, and what symbol is used to denote it?*

Many substances, upon assuming the crystalline form, take with them a definite number of molecules of water, which are necessary to the

maintenance of the peculiar form, and frequently of the color, but which in no way modify the chemical properties of the substance. This is called water of crystallization, and is denoted by the symbol Aq (Latin aqua = water).



Sodic sulfate with 10 molecules
water of crystallization.

80. *Explain the meanings of the terms anhydrous, deliquescent, and efflorescent.*

A substance is *anhydrous* when it contains no water. A *deliquescent* substance is a solid that has such a tendency to unite with water that it absorbs it from the air, becoming damp, and finally liquid. Crystalline bodies *effloresce* when, on exposure to air, they lose their water of crystallization and fall to powder.

81. *How can we prove by analysis that water has the composition H_2O ? (See Q. 12.)*

If we pass the current of a battery through acidulated water, the water is decomposed into its constituent gases, and, collecting these separately, we find one to be pure hydrogen and the other pure oxygen. For every one volume of oxygen collected we will obtain two volumes of hydrogen, and if we weigh these gases we will find that the hydrogen formed weighing 2, the oxygen will weigh 16; and as each atom of oxygen weighs 16, and each atom of hydrogen 1, the molecule of water is composed of one atom of oxygen combined with two atoms of hydrogen, and its formula is consequently H_2O .

82. *How can we prove synthetically that the composition of water is H_2O ? (See Q. 12.)*

1. If we make a mixture of 2 volumes of hydrogen with 1 volume of oxygen, and pass through it an electric discharge, chemical union will take place, the gases will disappear entirely, and in their place will remain a small quantity of water.

2. If we burn hydrogen in an atmosphere of oxygen, and collect the result, we will find it to be water. If in No. 1 we use more than 2 volumes of hydrogen, or more than 1 volume of oxygen, the excess will remain after the union. This is in obedience to the law of definite proportions.

83. *What influence has temperature upon a mixture of oxygen and hydrogen ?*

At the ordinary temperature a mixture of oxygen and hydrogen remains such indefinitely, no chemical union taking place ; but if the temperature be raised even at a single point in the mixture, as by applying a lighted match, or by the passage of an electric discharge, union takes place, and proceeds through the entire mass with great rapidity, causing a violent explosion.

This influence of temperature upon chemical action is one of great importance, and not to be lost sight of, especially in animal chemistry, as certain actions take place at the temperature of the body which are arrested when the temperature is raised or lowered a few degrees.

84. *What precaution is to be observed in experimenting with hydrogen ?*

As mixtures of hydrogen and air in certain proportions explode violently on contact with

flame, the latter should be completely expelled from the generator before the former is collected. Hydrogen, being exceedingly diffusible, should be freshly prepared when needed, lest it become mixed with air. Neglect of these precautions may cause serious accident.

85. *What is an hydroxid?*

A compound produced by the replacement of one-half the hydrogen of water by another element or a radical (see Q. 688): *e.g.*, potassium hydroxid, KHO ; calcium hydroxid, CaH_2O_2 .

86. *What is a hydrate?*

A compound containing chemically combined water. Thus, the crystalline solid $\text{H}_2\text{SO}_4, \text{H}_2\text{O}$ is a hydrate of sulfuric acid, H_2SO_4 .

87. *What is hydroxyl or oxhydryl?*

The group of atoms OH left by removal of H from H_2O .

88. *How are natural waters classified?*

First, into *unpotable* and *potable*. The former are *obviously* unfit for drinking, as sea water. The latter are *apparently* fit for domestic use.

Potable waters are classified into :

A. *Meteoric waters*—rain water, snow water.

B. *Surface waters*—rivers, lakes, ponds.

C. *Ground waters*—water saturating the superficial porous stratum of the earth: *e.g.*, well water.

D. *Deep waters*—those coming from below an impervious stratum: *e.g.*, spring and artesian-well waters.

89. *Which of these waters are most frequently contaminated?*

Surface waters and ground waters. (See Q. 96.)

WITHDRAWN

90. *What substances render a water unfit for drinking?*

1. An excess of solid matter, as in sea water and the water of mineral springs. 2. An excess of organic matter. 3. Poisonous metals, as lead or copper.

91. *What is meant by organic impurity?*

Low forms of vegetable life; decomposing animal or vegetable matter; contamination from admixture of sewage or of discharges from tanneries and from certain factories.

92. *Give a rough method of detecting organic impurity.*

Put a pint of water into a perfectly clean quart bottle, cork and shake strongly, remove the cork, and inhale the air of the bottle. If the water be much contaminated, and if the observer's sense of smell be acute, an offensive odor will be observed.

NOTE. This method is quite rough, and only very bad water will produce an odor. The best method of determining accurately to what extent a water is contaminated with organic matter is by the use of Wanklyn's process, which, unfortunately, is not adapted to the use of medical practitioners. See Manual, pp. 69-72.

93. *What waters are most liable to organic contamination?*

That of stagnant pools. That of rivers having a sluggish stream or flowing through towns or manufacturing districts. That of wells.

94. *What poisonous metal occurs most frequently, and how may it be detected?*

Lead. Take two tumblers full of the water, place them upon a sheet of white paper, and add

colorless ammonium sulfhydrate solution to one tumbler, and afterward hydrochloric acid. If the water to which the first reagent has been added becomes perceptibly darker than the other, and does not become colorless with hydrochloric acid, it is contaminated with lead or copper.

95. *What influence has the purity of water upon its power of dissolving lead?*

Perfectly pure, *unaërated* water has no action upon lead, and a bright strip of the metal will retain its lustre in it indefinitely. But if the water contain air in solution, the lead becomes oxidized, and the oxid dissolves in the water; the solvent power of the water being increased by the presence of chlorids or nitrates. If, on the other hand, the water hold in solution sulfates or carbonates or carbonic anhydrid (commonly called carbonic acid gas) in small amount, its power of dissolving lead is very much diminished, because these form upon the surface of the metal a coating of lead sulfate or carbonate, which are compounds insoluble in water, and which protect the lead from any further action of the water.

96. *What practical indications may be drawn from the last answer?*

1. Rain water should never be collected from roofs covered with lead, or in leaden tanks, because such water contains no fixed solids and is liable to contain nitric acid and nitrates; its solvent power for lead is therefore comparatively great. 2. A well or vessel for containing water should never have a leaden cover, because the water, evaporating from the surface, condenses upon the lead in a very pure form, as far as solids

are concerned, but highly aerated; it thus dissolves a portion of the oxidized metal, and, falling, carries it into the mass below.

97. *Explain what is meant by hard and soft water, and the cause of hardness.*

A water is said to be *hard* when it forms a curdy deposit with soap, and *soft* when soap dissolves in it without precipitation. The curdy deposit consists of the calcium and magnesium salts of the fatty acids, which are insoluble in water, and its formation indicates an excess of the salts of those metals.

98. *What is the difference between temporary and permanent hardness, and to what is it due?*

Temporary hardness is removed by boiling and filtering from the deposit so produced. Temporary hardness is due to bicarbonates of calcium and magnesium, which are soluble, but decomposed by boiling, with expulsion of carbon dioxide and precipitation of the insoluble carbonate. Permanent hardness is due to the sulfates, which are not decomposed by boiling.

99. *What are the physical characters of a good drinking water?*

It must be neither flat, salty, sweetish, nor otherwise disagreeable in taste; cool, limpid, clear, odorless; and capable of dissolving soap, without formation of a curdy precipitate.

N. B.—A water which does not fulfil these conditions is certainly unfit, one which does is not necessarily fit for drinking. See Manual, pp. 68-73.

100. *How may impure water be completely or partially purified for drinking purposes?*

Completely by distillation, but the product is flat in taste unless subsequently aërated and charged with a small quantity of salts. Partially by filtration and by boiling. The former process removes suspended impurities, and, if freshly-burnt animal charcoal be the filtering medium, dissolved impurities to some extent. By boiling, the water is softened, if temporarily hard, and, if the boiling be continued for half an hour, the probability of transmission of disease by bacteria is much diminished, if not removed. (See Manual, pp. 73-75.)

101. *Where does water exist in the animal economy?*

In all parts.

102. *What functions does water perform in the economy?*

In the liquid parts it holds the solids in solution (and it is of all liquids the best solvent we have); in the semi-solids it maintains the peculiar consistence of these parts. Many of the constituents of the body contain water as a part of their composition, and, when this water is driven off, their condition becomes so altered as to render them entirely unfit for the performance of their functions.

103. *By what channels is water eliminated from the system, and how does the amount discharged compare with that ingested?*

It is discharged in the urine, perspiration, expired air, and fæces. The amount discharged is greater than that ingested, the excess being formed by the oxidation of the hydrogen contained in the organic matters of the body.

104. *What is the formula of hydrogen dioxid ; and under what other names is it known ?*

H_2O_2 . Hydrogen peroxid ; peroxide of hydrogen ; oxygenated water ; golden liquid.

105. *Describe its properties.*

In the pure form a colorless, syrupy liquid, heavier than water, having a disagreeable metallic taste. In solution in water of 10 to 20 volume strength, a colorless liquid.

It is a powerful oxidizing agent, and in some cases also acts as a reducer. It is a strong bleacher and disinfectant. The pure substance yields 475 times its volume of oxygen when decomposed. The solution customarily used, 10 to 20 volumes.

106. *For what purposes is it used ?*

As a disinfectant ; as a bleacher ; in the laboratory as an oxidizer and for many other purposes ; for bleaching hair.

107. *Describe a reaction given by H_2O_2 but not by ozone.*

Add to the liquid a few drops of potassium dichromate solution and a little dilute sulfuric acid, and agitate with ether. The ether assumes a brilliant blue-violet color in the presence of H_2O_2 .

(See Manual, pp. 77, 78.)

CLASS II. ACIDULOUS ELEMENTS.

108. *What are the characteristics of the acidulous elements?*

Their oxids combine with water to form acids, never to form bases. They do not displace the hydrogen of oxyacids to form oxysalts.

109. *What name is sometimes used to designate the elements of this class?*

The metalloids.

110. *Name the principal elements included in this class.*

Chlorin, bromin, iodin, sulfur, nitrogen, phosphorus, arsenic, antimony, boron, carbon, and silicon.

GROUP I. THE HALOGENS.

FLUORIN		F	..	19.
CHLORIN		Cl.		35.5
BROMIN		Br		80.
IODIN		I		127.

111. *Name the elements constituting the chlorin group.*

Fluorin, chlorin, bromin, iodin.

112. *Describe the common properties of the elements of this group.*

They are univalent. They form compounds

with hydrogen, containing one volume of the element, in the gaseous state, combined with one volume of hydrogen, which are monobasic acids. Their hydroxids are monobasic acids (fluorin forms no hydroxid). They are all possessed of bleaching and disinfecting powers.

113. *What name is applied to the group?*

The halogens.

FLUORIN.

114. *What are the symbol, and atomic and molecular weights of fluorin?*

F. 19. 38.

115. *Describe the prominent properties of fluorin.*

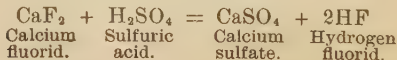
A yellowish-green gas. Decomposes H_2O with formation of HF and ozone. Detonates violently on contact with H. Attacks organic substances energetically. In it Si, Bo, As, Sb, S, and I ignite spontaneously.

116. *What compound of fluorin with hydrogen is known, and what are its uses and properties?*

Hydrofluoric acid, or hydrogen fluorid, HF . A colorless gas, soluble in water, highly acid and corrosive. It is used, either as gas or in solution, for etching on glass, which it attacks with great energy.

117. *How is HF obtained, and what precautions are to be observed?*

It is prepared by the action of sulfuric acid upon fluorspar :



The operation must be performed in vessels of lead or of platinum.

Great care is to be had that the gas is not inhaled, and that the skin is not exposed to it, as, in a few instants, it produces painful blisters, afterwards forming open wounds, which are very painful and heal with great difficulty.

CHLORIN.

118. *What are the symbol, and atomic and molecular weights of chlorin?*

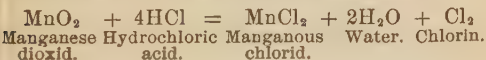
Symbol Cl. Atomic weight 35.5. Molecular weight 71.

119. *How does it exist in nature?*

It is not found free, but is very abundant in combination, notably in common salt.

120. *How is it prepared?*

There are three principal methods: 1. By the decomposition of its hydrogen compound (*i.e.*, muriatic acid) by black oxid of manganese:



2. By decomposition of common salt, 1 part of which, mixed with 1 part of finely powdered manganese dioxid, is heated with 3 parts commercial sulfuric acid. 3. When comparatively small quantities of Cl are required, it may be obtained by exposing chloride of lime, moistened with water or with dilute acid. This is a convenient method when the gas is required for disinfection of limited spaces or for inhalation.

121. *State the more prominent physical properties of Cl.*

It is a greenish-yellow gas, having a very penetrating, suffocating odor, acting energetically upon the air-passages even when dilute, producing coughing, inflammation, and hæmoptysis. It is $2\frac{1}{2}$ times heavier than air, and, as it is quite soluble in water, should be collected by allowing the delivery tube to reach to the bottom of a jar, whose opening is directed upwards, when the Cl collects from the bottom, driving the air out above it. It is liquefied by a pressure of $8\frac{1}{2}$ atmospheres, and liquid chlorin is now used industrially.

122. *What is aqua chlori (U. S.), or liquor chlori (Br.)?*

A solution of Cl in water, saturated at the temperature of the air.

123. *Does Cl unite with other elements readily?*

It does. It unites directly with all elements except fluorin, oxygen, nitrogen, and carbon, and with these it unites indirectly. This union of Cl with other elements is frequently attended by the appearance of light and heat: When a candle is burnt in Cl, the hydrogen of the candle unites directly with the Cl, giving off light and heat, while the carbon, being incapable of union with Cl under these conditions, rises as a dense smoke.

124. *When chlorin and hydrogen combine, what substance is formed?*

Hydrochloric acid.

125. *In what proportionate volumes do these two gases combine?*

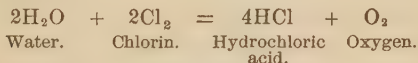
In equal volumes.

126. *Under what conditions does the combination occur?*

A mixture of Cl and H may be kept indefinitely at ordinary temperatures, and in the dark, without union taking place. When the mixture is exposed to diffuse sunlight the combination takes place gradually, but if the mixture be exposed to the direct rays of the sun, or to certain strong artificial lights, or if a spark be passed through the mixture, combination occurs instantly with an explosion.

127. *What change takes place when a solution of Cl in H_2O is exposed to light?*

Under the influence of light, Cl decomposes H_2O , with formation of hydrochloric acid, while O is liberated :



128. *Why is the equation in the last answer not written $H_2O + 2Cl = 2HCl + O$?*

Because that would indicate that a single atom of O could exist uncombined. Atoms, when liberated from one combination, immediately combine with other atoms to form new molecules (see Q. 8).

129. *How does Cl act as a bleaching, deodorizing, and disinfecting agent?*

Indirectly as a powerful oxidizing agent. It decomposes the H_2O present, according to the equation given above, and the O, being in the nascent state, acts energetically. Cl will not bleach a perfectly dry substance.

130. *What is meant by the nascent state, and how is the superior energy of elements in this state explained?*

An element is said to be in the nascent state (the state of being born) at the instant that it is set free from one of its compounds. Free oxygen exists as a collection of molecules of oxygen, each molecule consisting of two atoms. When oxygen is liberated from a compound it is set free, first as individual atoms; these, however, not being capable of existing free, immediately unite in pairs to form molecules. But if, at the instant at which oxygen is liberated, there be present any substance with which oxygen has a great tendency to combine, its atoms enter into combination with this rather than with each other. As the force required to break up the molecule of oxygen is in this case not required, the combination takes place readily.

131. *What are the names and formula of the compound of chlorine and hydrogen?*

Hydrogen chlorid, or hydrochloric acid— HCl .

132. *What are the physical properties of this substance?*

It is a colorless gas; gives off thick white fumes on contact with moist air; has a very sharp, penetrating odor, producing great irritation of the respiratory passages and attacking the skin; reddens litmus; does not burn in air or support combustion; exceedingly soluble in water; heavier than air. Sp. gr. 1.293.

133. *What are the hydrochloric or muriatic acids of the arts and pharmacy?*

Solutions of this gas in water, of varying strength and purity.

134. *What varieties are there? Describe them.*

Commercial: A yellow liquid, having usually a sp. gr. of about 1.16; contaminated with iron and chlorids of sodium and arsenic; used for manufacturing and rough chemical purposes.

Pure: Acidum hydrochloricum, U. S., Br. A colorless liquid, being a pure solution of HCl in water, of about the same strength as the last. Sp. gr. 1.16.

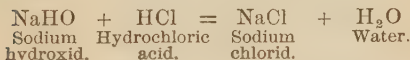
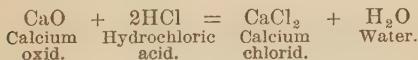
Acidum hydrochloricum dilutum, U. S., Br. The last-named diluted with water to sp. gr. 1.049 = 10 per cent. HCl (U. S.); sp. gr. 1.052 = 10.5 per cent. HCl (Br.).

135. *Name the three strong mineral acids.*

Hydrochloric, sulfuric, and nitric acids.

136. *What is the action of hydrochloric acid with a metallic oxid or hydroxid?*

Both are decomposed, while water and a chlorid are formed, thus:



137. *What is aqua regia?*

A mixture of nitric and hydrochloric acids in the proportion of 1HNO₃ to 3HCl, or three parts by weight of nitric acid to five of hydrochloric. The acids react upon each other with liberation of Cl, which, being in the nascent state, combines with the noble metals, gold and platinum, if they be present. From this fact the name is

derived, gold having been considered by the older chemists as the king of metals. The mixture is also known as nitrohydrochloric or nitromuriatic acid.

In the dilute form, it is used in medicine under the name *Acidum nitrohydrochloricum*, U. S., Br.

138. *Describe the tests for the soluble chlorids and hydrochloric acid.*

1. With silver nitrate, a white, flocculent precipitate, insoluble in nitric acid, readily soluble in ammonium hydroxid.

2. With mercurous nitrate, a white precipitate, turning black on addition of ammonium hydroxid.

139. *What chlorids are insoluble or very difficultly soluble in water?*

Those of lead, silver, and mercury (calomel).

140. *How may they be distinguished from each other?*

By adding ammonium hydroxid. If the substance be silver chlorid it is dissolved, if it be mercurous chlorid it turns black, and if it be lead chlorid it remains unaltered.

141. *Does free hydrochloric acid exist in the body?*

Yes. It is the free acid of the gastric juice.

142. *Define a poison.*

Any substance which, being in solution in the blood, may produce death or serious bodily harm.

143. *Define a corrosive.*

A substance capable of producing death or injury by its chemical action upon a tissue with which it comes in direct contact.

144. *In what other respects do corrosives and poisons differ?*

Corrosives act upon dead and living tissue alike, while poisons, as a rule, do not. The violence of corrosion is directly proportionate to the degree of concentration, while the action of poisons depends upon the actual quantity absorbed, but in no wise on the degree of concentration of the solution taken. A corrosive may kill by destroying the skin, producing an injury resembling a burn; the poisons, if applied to the skin, act only when absorbed.

145. *May the same substance be a corrosive and also a poison?*

Yes. Oxalic acid in concentrated solution acts primarily as a corrosive. In dilute solution it does not corrode the stomach, but acts as a poison.

146. *Are the mineral acids poisons or corrosives?*

They are corrosives.

147. *Describe the prominent symptoms produced by the mineral acids.*

Acute, burning pain, extending from the mouth to the stomach, referred chiefly to the epigastrium, and beginning *immediately*. Violent and distressing vomiting of dark, tarry, or "coffee-ground" and highly acid material. Eschars, at first white or gray, later brown or black, are formed where the acid has come in contact with the skin, lips, or tongue.

148. *How does death occur?*

Either within twenty-four hours from collapse; more suddenly from perforation and opening of large blood vessels; or after several weeks or months from starvation, due to destruction of

gastric cells or closure of the pylorus by inflammatory thickening.

149 *In what respects does hydrochloric acid differ from nitric and sulfuric in its action on the economy?*

The HCl gas, escaping from the solution, enters the air passages, and causes serious interference with respiration, dyspnoea, stridulous, frequent, and moaning breathing, and loss of articulation.

150. *What should be the treatment in corrosion by mineral acids?*

The object is to dilute and to neutralize the acid and convert it into a harmless salt. For this purpose the best agent is magnesia (magnesia usta) suspended in water; or, if this be not at hand, a strong solution of soap. Chalk and the carbonates or bicarbonates of sodium and potassium should *not* be given, as they generate large volumes of gas. The scrapings of a plastered wall are entirely useless. The stomach pump, or any attempt at the introduction of a tube into the oesophagus, is not to be thought of.

151. *Describe the post-mortem appearances caused by hydrochloric acid.*

The pharynx, larynx, and oesophagus are highly inflamed; the mucous membrane sloughed off in places. The internal surface of the stomach is dark red or even black; the walls much thinned, or even perforated and softened. If death has resulted secondarily (see Q. 148), more or less of the stomach is found white or gray and thickened, particularly at the pylorus, which may be so small as not to admit a fine knitting needle.

152. *What is a general characteristic of the compounds of chlorin with oxygen?*

They are all very unstable, being decomposed by very slight influences and frequently with explosion.

BROMIN.

153. *What are the symbol, and atomic and molecular weights of bromin?*

Symbol = Br. Atomic weight = 80. Molecular weight = 160.

154. *What are its physical properties?*

It is a dark-brown liquid, giving off brown fumes freely when exposed to the air; has a strong, disagreeable odor, and is very irritating to mucous surfaces. It is sparingly soluble in water.

155. *How does bromin exist in nature?*

It is not found free, but exists in small proportion, widely diffused, however, in combination with potassium, sodium, and magnesium, in sea plants, and in the waters of the sea and of certain mineral springs.

156. *How does bromin compare with chlorin in its chemical actions?*

Its actions are very similar to those of chlorin, but less intense; it forms compounds similar to those of chlorin, and is a good bleaching and disinfecting agent. Chlorin drives bromin out of its combinations. When chlorin acts upon a bromid in solution, a chlorid is formed, while bromin is set free.

157. *Describe the tests for a bromid.*

1. With silver nitrate solution, a yellowish-

white precipitate, which is insoluble in nitric acid; soluble in a large excess of ammonium hydroxid.

2. Add a few drops of chlorin water (to liberate the bromin), and then some chloroform; shake; the chloroform is colored yellow by bromin.

3. Repeat 2, using starch paste instead of chloroform; the liquid is colored yellow.

IODIN.

158. *Give the symbol, and atomic and molecular weights of iodin.*

Symbol = I. Atomic weight = 127. Molecular weight = 254.

159. *How does it occur in nature?*

In the form of iodids in mineral waters, in sea water, and in animals and vegetables inhabiting the latter.

160. *Describe the principal physical properties of iodin.*

A blue-gray solid in scales, having a metallic lustre. Volatile at all temperatures, the vapor having a beautiful violet color and a peculiar odor. Fuses at $113^{\circ}.6$ C. ($236^{\circ}.5$ F.). Dissolves readily in chloroform and in carbon disulfid, forming violet-colored solutions; also in alcohol, forming a brown solution. Sparingly soluble in H_2O .

161. *How may the amount of iodin in aqueous solution be increased?*

Water which stands in contact with excess of iodin continues to dissolve it. The H_2O is par-

tially decomposed by the I, with formation of hydriodic acid (see Q. 162), in a solution of which I is more soluble than in pure H_2O .

The presence of certain salts, as potassium iodid, ammonium chlorid and nitrate, etc., increases the solvent power of H_2O for I. A solution of I in potassium iodid solution is used medicinally under the name of Lugol's solution, or Liq. Iodi Comp., U. S.; Liquor Iodi, Br.

162. *Describe the chemical properties of iodin.*

They are very similar to those of Cl and Br, but less active than either, I being driven out of its binary compounds by either Cl or Br. It decomposes H_2O slowly, and hydrogen sulfid rapidly, with formation of hydriodic acid and liberation of O or sulfur. Nitric acid oxidizes it to iodic acid.

163. *How may free iodin or an iodid be detected?*

1. Iodids with silver nitrate solution form a yellow precipitate, insoluble in nitric acid or in ammonium hydroxid.

2. Add fuming nitric acid to solution of an iodid, then chloroform, and agitate; the chloroform (lower) layer is colored violet.

3. Add palladic chlorid to solution of an iodid; a dark-brown precipitate.

4. Free iodin colors starch paste dark violet-blue.

164. *What compound of hydrogen and iodin is known?*

Hydriodic acid, or hydrogen iodid, HI.

165. *What are its properties?*

It is a colorless gas, very soluble in water.

Its concentrated aqueous solution has a strong acid reaction, and fumes when exposed to the air. It is decomposed by Cl, Br, oxidizing agents, sulfuric acid, etc., etc. When exposed to the air, the oxygen unites with the hydrogen of the acid, forming water, while the iodine is set free, and dissolved in the remaining acid until this becomes saturated with iodine, when the remainder is precipitated in the solid form. It behaves with metals and their hydroxids like hydrochloric acid.

GROUP II. SULFUR GROUP.

SULFUR.....	S	32.
SELENIUM	Se	79.5
TELLURIUM.....	Te	128.

166. *Describe the common properties of the elements of this group.*

They are bivalent. Each forms a hydrogen compound, containing an atom of the element and two atoms of hydrogen, which is a weak dibasic acid. Their oxyacids are all dibasic.

SULFUR.

167. *What are the symbol, and atomic and molecular weights of sulfur?*

Symbol = S. Atomic weight = 32. Molecular weight = 64.

168. *How does S occur in nature?*

Free, and in combination in sulfids, sulfates, and organic compounds.

169. *Describe the prominent physical properties of sulfur.*

A yellow, crystalline solid, white when in a finely-divided state, having faint though characteristic odor and taste. It fuses at 114° ($237^{\circ}.2$ F.), and boils at 440° (824° F.). It is insoluble in H_2O , soluble in carbon disulfid and in protochlorid of sulfur.

170. *What is the difference between roll sulfur, flowers of sulfur, and precipitated sulfur?*

Roll sulfur is prepared by pouring melted S into moulds, which are cooled. *Flowers* of sulfur are obtained by mixing vapor of S with cold air, when the S assumes the solid form in small feathery crystals. *Precipitated* sulfur, or *sulfur precipitatum*, U. S., is obtained by decomposing a sulfid, S being precipitated in the amorphous condition and in a very fine state of subdivision.

171. *What occurs when sulfur is heated in contact with air?*

It burns with a blue flame at about 250° , uniting with the O of the air to form sulfur dioxid— SO_2 .

172. *Does sulfur unite directly with any other elements?*

Yes; many metals burn in vapor of S, with formation of sulfids. Sulfur also burns in an atmosphere of H, with formation of hydrogen sulfid.

COMPOUNDS OF SULFUR.

173. *What is an important compound of sulfur and hydrogen, and with what oxygen compound does it correspond?*

Hydrogen sulfid, also known as sulfuretted hydrogen— H_2S . It corresponds with H_2O , only in place of O there is S, and in each one atom of the bivalent O or S is united with two atoms of the univalent H:

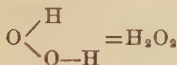


Water.
(Hydrogen oxid.)

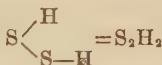


Hydrogen sulfid.

[There is another compound of S and H corresponding to H_2O_2 :]



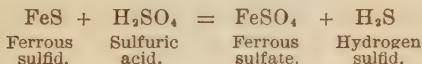
Hydrogen
dioxid.



Hydrogen
disulfid.

174. *How may H_2S be prepared?*

By treating ferrous sulfid with dilute sulfuric acid :



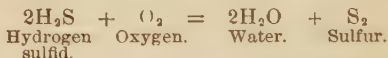
Also by decomposing antimony trisulfid or calcium sulfid by HCl .

175. *What are the principal physical properties of hydrogen sulfid?*

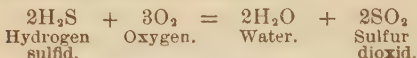
It is a colorless gas, having an exceedingly offensive odor of rotten eggs and a correspondingly disgusting taste. Heavier than air (sp. gr. 1.19). Under a pressure of 17 atmospheres it forms a colorless, mobile fluid which crystallizes at -85° (-123° F.). Soluble in water, the solution having an acid reaction, and being decomposed with deposition of S when exposed to the air for some time.

176. *What are the products of combustion of H_2S ?*

If the supply of O be small, with formation of H_2O and deposition of solid S :



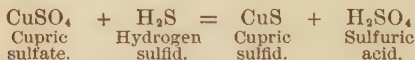
If, however, the supply of O be sufficient, the products are entirely gaseous :



Mixtures of air or oxygen with H_2S are explosive.

177. *When H_2S is passed through a solution of a salt, what takes place?*

Both the gas and the salt are decomposed, with formation of a sulfid, and regeneration of the acid :



178. *What use is made of this reaction in analysis?*

The sulfids of the different metals, formed as above, vary in their color and in their solubility in acidulated H_2O ; therefore, by passing H_2S through a solution, we can determine whether certain metals are present or not, according as insoluble, colored precipitates are or are not formed. (See Laboratory Guide, 3d Ed., pp. 21-32.)

179. *How may the presence of H_2S or of a sulfid be detected?*

1. H_2S colors paper moistened with lead acetate solution brown or black.

2. H_2S has the odor of rotten eggs.

3. A sulfid is decomposed by HCl , yielding H_2S , whose presence is then shown by 1 and 2.

180. *In what gaseous mixtures does H_2S occur?*

In sewer gas, in the emanations from dead bodies, and in the gases discharged from volcanoes.

181. *What should be the treatment in H_2S poisoning?*

Plenty of fresh air, cold affusions, hot brandy and water, inhalation of chlorin largely diluted with air.

182. *What oxids of sulfur are known?*

Sulfur dioxid, SO_2

“ trioxid, SO_3

183. *What is another name for sulfur dioxid?*

Sulfurous anhydrid; also improperly called sulfurous acid.

184. *Why is the name sulfurous acid an improper one for this compound?*

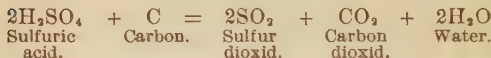
Because it contains no H , which enters into the composition of every acid. The true sulfurous acid is a compound of the anhydrid with H_2O :



185. *How may SO_2 be prepared?*

It is formed whenever S is burnt in air, and is

also obtained by decomposing sulfuric acid with charcoal or metallic copper :



The copper or coal and the requisite sulfuric acid are placed in a flask, which is heated.

186. *Describe the principal physical properties of SO₂.*

A colorless gas, having a suffocating odor (sulfur matches) and a disagreeable and persistent taste. More than twice as heavy as air (sp. gr. 2.317). Liquefies at -10° ($+14^\circ$ F). It is very soluble in H₂O, which takes up about 40 times its volume at the ordinary temperature.

187. *What is the Acidum sulfurosum U. S., Br.?*

An almost saturated solution of SO₂ in water.

188. *Is this simply a solution of SO₂?*

No; it contains the true H₂SO₃, sulfurous acid, formed by the union of SO₂ + H₂O.

189. *What is SO₂ used for?*

As a bleaching and disinfecting agent, and in the manufacture of sulfuric acid.

190. *What action has SO₂ on the economy when inspired?*

In a concentrated form it is poisonous. When diluted with air it produces irritation of the air passages. Individuals may, however, become by degrees habituated to its presence in air, in quan-

tities which would prove fatal to those not so trained.

191. *What substance is represented by the formula SO_3 ?*

Sulfur trioxid, or sulfuric anhydrid.

192. *State the properties of SO_3 .*

It occurs as long, colorless, transparent prisms, which at $18^{\circ}.3$ (65° F.) melt to an oily liquid, boiling at 46° ($114^{\circ}.8$ F.) When exposed to the air it gives off dense white fumes. In the absence of H_2O it has no effect upon litmus paper. It has a great tendency to unite with H_2O to form sulfuric acid, and if dropped into H_2O produces a hissing noise from the violence of the action.

193. *What is the compound having the formula H_2SO_3 ?*

Sulfurous acid.

194. *Give the formula of sulfuric acid.*

H_2SO_4 .

195. *What is the common name of H_2SO_4 ?*

Oil of vitriol.

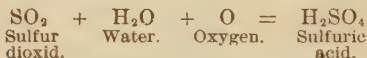
196. *What is its basicity? How many sulfates of sodium and of calcium are there, and what are they?*

It is dibasic. There are two sulfates of sodium: monosodic sulfate, $NaHSO_4$, and disodic sulfate, Na_2SO_4 ; and one sulfate of calcium, calcium sulfate, $CaSO_4$.

197. *Give a general idea of the principle of manufacture of sulfuric acid.*

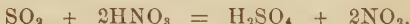
Sulfurous anhydrid is obtained by heating either S or a natural compound of S and iron, called iron pyrites, in a current of air. The

anhydrid thus obtained is caused to unite with H_2O and O :



The actual reactions are :

First. SO_2 is oxidized by nitric acid, with liberation of nitrogen tetroxid :



Second. The nitrogen tetroxid so formed combines with H_2O to regenerate nitric acid and form nitrogen dioxide :



Finally, the dioxide so produced is oxidized by air to the tetroxid, which again regenerates nitric acid :



The nitric acid therefore acts as a carrier of O from the air to the SO_2 .

The acid so obtained is concentrated by evaporation of the H_2O mixed with it, first in pans of lead, and subsequently in retorts of glass or platinum.

198. *Describe the prominent physical properties of pure H_2SO_4 .*

A dense, oily, colorless liquid. Sp. gr. 1.842. Boils at 338° (640° F.), distilling in great part unchanged. Odorless, intensely acid in taste and reaction, and highly corrosive. Non-volatile at ordinary temperatures.

199. *Describe the principal chemical characters of H_2SO_4 .*

Heated with S, C, Hg, Cu, or Ag, it is reduced, with formation of SO_2 . It has a great tendency to unite with H_2O to form definite hydrates one of which, $H_2SO_4 \cdot H_2O$, crystallizes at $8^\circ.5$ ($47^\circ.3$ F.), and is known as glacial sulfuric acid. When H_2SO_4 and H_2O are mixed, there is marked elevation of temperature. H_2SO_4 absorbs H_2O from the air, and removes its elements from organic substances, which are thereby blackened from liberation of their carbon, *i.e.*, are charred.

200. *Name and describe the varieties of this acid used in the arts and in pharmacy.*

Commercial: An oily liquid, with a brownish tinge (due to charred organic matter), sp. gr. 1.83 to 1.84, and containing 93 to $99\frac{1}{2}$ per cent. of true H_2SO_4 .

Pure: *Acidum sulfuricum*, U. S., Br.: a colorless, oily liquid, having sp. gr. 1.84.

Acidum sulfuricum dilutum, U. S., Br., is a dilute acid of 1.069 sp. gr. and 9 to 10 per cent. H_2SO_4 , U. S.; sp. gr. 1.094 and 12 to 13 per cent. H_2SO_4 , Br.

201. *What is Nordhausen sulfuric acid?*

A brown liquid, obtained by distilling green vitriol ($FeSO_4$), and used in dyeing as a solvent of indigo. It is a mixture of SO_3 with *pyro-sulfuric acid*, $H_2O_7S_2$, which is itself a compound of $H_2SO_4 + SO_3$.

202. *Describe the tests for soluble sulfates or sulfuric acid.*

1. With barium chlorid, nitrate, or acetate, a

white precipitate, insoluble in HCl or in nitric acid.

2. With lead acetate, a white precipitate, insoluble in dilute acids.

3. With calcium chlorid, a white precipitate, either immediately or on dilution with two volumes of alcohol ; insoluble in dilute acids.

Toxicology of H_2SO_4 , see Q. 147-151.

203. *How may stains of sulfuric, hydrochloric, and nitric acids on cloth be distinguished from each other?*

When not too old, stains of H_2SO_4 and HCl are bright red, the latter the brighter of the two. They disappear permanently when moistened with aqua ammoniæ. Those of nitric acid are of a yellowish tinge, and are not removed by aqua ammoniæ.

GROUP III. NITROGEN GROUP.

NITROGEN.....N.....	14
PHOSPHORUS.....P.....	31
ARSENIC.....As.....	75
ANTIMONY.....Sb.....	120

204. *Describe the common properties of the elements of this group.*

They are trivalent or quinquivalent. Each forms a hydrogen compound, containing three atoms of hydrogen, combined with one atom of the element. These hydrogen compounds are not acid but basic in their nature. The oxyacids differ in basicity from monobasic to tetrabasic.

NITROGEN.

205. *Give the symbol, and atomic and molecular weights of nitrogen.*

Symbol = N. Atomic weight = 14. Molecular weight = 28.

206. *Where does N occur in nature?*

Free in atmospheric air; in combination in the nitrates, in ammoniacal salts, and in organic compounds.

207. *State the more prominent properties of nitrogen.*

It is a colorless, odorless, tasteless gas; lighter than air (sp. gr. 0.972 — air = 1). Very spar-

ingly soluble in water, more soluble in alcohol. Chemically, it is noticeable from its negative characters. It does not burn or support combustion. It does not unite with other elements directly, or does so with great difficulty. Its compounds are nearly all very prone to decomposition. It does not support respiration, but has no positively deleterious action upon the economy.

208. *What are the constituents of atmospheric air?*

Oxygen and nitrogen; with small quantities of carbonic anhydrid, vapor of water, ammonia, and nitric acid.

209. *What is the proportion by volume of nitrogen to oxygen in air?*

79 of nitrogen to 21 of oxygen.

210. *Does this proportion vary much in free air?*

No. Although air is a mere mixture, the proportion of its chief constituents remains pretty much the same at different times, seasons, and elevations above the sea level.

211. *What is observed with regard to the solubility of air in water?*

All water, even that which has been recently distilled, contains air in solution, and it is from the air so held in solution that aquatic animals, breathing by means of gills, obtain the oxygen which they require. As air is a mixture, it has not a solubility of its own, but each constituent gas is dissolved according to its solubility; and as oxygen is more soluble in water than nitrogen, the air in solution in water has not the composi-

tion 79 nitrogen to 21 oxygen, but 65 nitrogen to 35 oxygen.

(See carbonic anhydrid, Q. 828 *et seq.*).

212. *What compounds of nitrogen and hydrogen are known?*

Ammonia, NH_3 ; Hydrazin, N_2H_4 ; and Hydrazoic acid, N_3H .

(See Manual, p. 105.)

213. *What are the physical properties of ammonia?*

It is, under ordinary conditions of temperature and pressure, a colorless gas, having a pungent, irritating odor and a caustic taste. It dissolves in H_2O to the extent of 1,050 volumes to one at 0° , and is also very soluble in alcohol.

214. *Describe its chemical characters.*

It does not burn readily, but may be made to do so when mixed with O . It combines with H_2O to form a highly alkaline liquid, containing ammonium hydroxid, NH_4HO . It combines directly with acids, without separation of hydrogen, to form ammoniacal salts:



(See ammonium compounds, Q. 549 *et seq.*).

215. *Give the formula and describe the relations of hydroxylamin.*

NH_2HO . It is intermediate in composition between ammonia, NH_3 , and ammonium hydroxid, NH_4HO , and may be considered as ammonia one of whose hydrogen atoms has been replaced by hydroxyl, OH : thus, $\text{OH}, \text{H}_2\text{N}$. It is consequently an amin. (See Q. 769, and Manual, pp. 105, 274.)

216. *What compounds of N and O are known?*

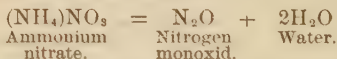
Nitrogen monoxid.....	N_2O
“ dioxid.....	NO
“ trioxid.....	N_2O_3
“ tetroxid.....	NO_2
“ pentoxid.....	N_2O_5

217. *By what other names is nitrogen monoxid known?*

Nitrous oxid; laughing gas.

218. *By what method is it prepared?*

By heating ammonium nitrate to a temperature not exceeding 250° (482° F.), when it is split up into N_2O and water—thus:



219. *State some of the physical properties of N_2O .*

It is a colorless, odorless gas, having a sweetish taste; heavier than air, sp. gr. 1.527; somewhat soluble in water, more so in alcohol.

220. *How does N_2O rank as a supporter of combustion and respiration?*

After oxygen, it is the best we have; a glowing match-stick rekindles when immersed in the gas, as it does in oxygen; phosphorus and other combustible substances burn in N_2O with almost as much brilliancy as in oxygen, this being due to the fact that at the temperature produced N_2O is decomposed into N and O, and in this mixture the O is in much larger proportion than in air. An animal will also live longer in an atmosphere of

N_2O than in any other gas than air or oxygen ; but, although the supply of gas be maintained and the products of respiration be removed, the animal eventually dies of asphyxia.

221. *What effect has N_2O upon the system when inhaled?*

It produces, first, exhilaration, frequently accompanied by laughter, and a tendency to muscular exertion, the patient sometimes becoming aggressive; afterwards loss of consciousness and complete anæsthesia.

222. *What precautions are to be observed in the preparation of N_2O for use as an anæsthetic?*

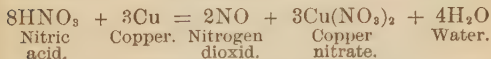
The temperature of the retort must not be allowed to rise beyond 250° (482° F.), lest the gas produced be contaminated with the higher oxids of nitrogen. The ammonium nitrate used should be absolutely free from ammonium chlorid, or the N_2O will be contaminated with chlorin.

223. *By what other name is nitrogen dioxid known?*

Nitric oxid.

224. *How is NO prepared?*

By the action of copper on nitric acid :



225. *What are its physical properties?*

A colorless gas, sparingly soluble in water. Its taste and odor are unknown.

226. *What takes place when NO comes in contact with air or oxygen?*

NO immediately unites with O to form NO_2 .

227. *What is another name for nitrogen tri-oxid?*

Nitrous anhydrid ; improperly, nitrous acid.

228. *Under what name is nitrogen tetroxid sometimes improperly designated?*

Hyponitric acid.

229. *State its properties.*

It is a brown gas, having a disagreeable, suffocating odor ; it is very irritating to the respiratory passages, colors the skin yellow, and is an energetic oxidizing agent.

230. *How is it formed?*

Whenever a metal, as copper, silver, or mercury, is dissolved in nitric acid, the acid is decomposed, as in Q. 611 ; the NO formed, as soon as it comes in contact with air, absorbs O and is converted into NO₂. As this gas is very deleterious, care should be had that it have a free exit into the open air whenever nitric acid is decomposed, as in the formation of metallic nitrates.

231. *What is another name for nitrogen pent-oxid?*

Nitric anhydrid.

232. *How many nitrogen acids are there, and what are they?*

Three :

Hyponitrous acid—HNO.

Nitrous acid—HNO₂.

Nitric acid—HNO₃.

233. *Give the formula and basicity of nitric acid.*

HNO₃. Monobasic.

234. *What is a common name for nitric acid?*

Aqua fortis.

235. *How does it exist in nature?*

It exists in combination with the metals as nitrates. Those of potassium and sodium are the most abundant and are the chief sources of nitric acid. Ammonium nitrate occurs in small quantities in atmospheric air, especially after thunder showers.

236. *What is the principle of the manufacture of HNO_3 ?*

Sulfuric acid is caused to act upon potassium or sodium nitrate, when :

237. *What are the physical properties of pure nitric acid?*

A colorless liquid, having a penetrating odor and an intensely sour taste. When cooled to -40° (-40° F.) it forms a solid. It boils at 86° (186° .8 F.).

238. *State some of the chemical properties of HNO_3 .*

It has a strongly acid reaction. It acts energetically upon all animal tissues, decomposing them, and turning such as contain albuminoid substances yellow. It gives up part of its oxygen with great readiness, and is, therefore, a powerful oxidizing agent. It is readily decomposed by most metals, with formation of nitrates. When exposed to air and light, it becomes yellow and is decomposed into NO_2 , H_2O , and O .

239. *Name and describe the varieties of HNO_3 met with in commerce and pharmacy.*

Commercial : A yellow liquid, contaminated with the oxids of nitrogen, HCl , arsenic, and other impurities. It is met with in two degrees of strength : *Single aqua fortis* = 39 per cent. HNO_3 ; and *double aqua fortis* = 64 per cent. HNO_3 .

Fuming : A concentrated acid, containing much nitrogen tetroxid, which gives it a deep yellow color. It is a powerful oxidizing agent.

Chemically pure (C. P.) acid : Perfectly colorless ; sp. gr. 1.521. Should be kept in bottles completely filled, and protected from the light.

Acidum nitricum, U. S., Br., a colorless acid, of sp. gr. 1.42 = 70 per cent. HNO_3 .

Acidum nitricum dilutum, U. S., Br., the last-named diluted ; sp. gr. 1.059 = 10 per cent. HNO_3 , U. S. ; sp. gr. 1.101 = 17.44 per cent., Br.

240. *Describe the tests for nitrates or HNO_3 .*

1. Add an equal volume of H_2SO_4 , cool, and float on the surface of the liquid a solution of ferrous sulfate ; the lower layer becomes gradually brown, black, or purple, beginning at the top.

2. Boil in a test tube some HCl containing enough indigo-carmin to color it blue, add the liquid to be tested, and boil again ; the color is discharged.

3. If acid, neutralize with potassium hydroxid, evaporate to dryness, moisten with H_2SO_4 , and add a crystal of brucin ; a red color.

4. Add H_2SO_4 and fragments of copper ; boil ; brown fumes. (See Manual, pp. 110, 111.)

241. *What is the appearance of stains upon the skin or mucous membrane caused by HNO_3 ?*

Not red as with HCl or H_2SO_4 , but at first yellow, changing to dirty brownish-yellow.

(Toxicology, see Q. 147-151.)

PHOSPHORUS.

242. *Give the symbol, and atomic and molecular weights of phosphorus.*

Symbol = P. Atomic weight = 31. Molecular weight = 124.

243. *Of how many atoms does the molecule of phosphorus consist?*

Of four.

244. *How does phosphorus exist in nature?*

It is not found in its own form, but is widely distributed in combination in the three kingdoms of nature. In the animal it occurs both oxidized in the form of phosphates (the phosphorus used in the arts is obtained from calcic phosphate), as well as in certain organic compounds entering into the composition of nerve tissue.

245. *What is meant by allotropy?*

Some elements, as phosphorus and carbon, exist in two or more forms, in which, although the chemical relations remain unaltered in kind, the physical properties vary; these different conditions of the same element are said to be allotropic.

246. *In how many allotropic conditions does phosphorus exist, and what are they?*

Four—black, white, red, and yellow. Of these, the last two are the most frequently met with.

247. *What are the physical properties of the ordinary, or yellow, variety?*

When freshly prepared, and at ordinary temperatures, it forms a yellowish, translucent solid, which, on exposure to light, becomes more darkly colored and opaque. It has the consistence of wax. When exposed to the air it gives off white fumes and an odor of garlic. At 0° (32° F.) it becomes brittle; at 44° (111° F.) it melts to a yellowish liquid, and at 290° (554° F.), in the absence of air, is converted into a colorless vapor. In air, at 60° (140° F.), it ignites, burning with a bright flame and giving off dense white fumes. Owing to the readiness with which Pignites, and the painful nature of the burns produced by it, it should never be cut except under H_2O , and should not be handled except with forceps. In the dark this form of P gives off a peculiar pale light. It is insoluble in H_2O ; sparingly soluble in alcohol, ether, and the fatty and ethereal oils; very soluble in carbon disulfid, from which solution it separates in the form of crystals.

248. *What are the physical properties of the red variety?*

It is red, brown, or dark yellow in color. It may be heated to 250° (482° F.) without melting, but at that temperature it is suddenly converted into the yellow variety, which ignites with an explosion. It fires much less readily than yellow phosphorus, and may be kept dry, while the yellow must be preserved under H_2O . It has no odor or taste, and is insoluble in those substances which dissolve the other form.

249. *What is the most important difference between the two forms?*

The yellow variety is exceedingly poisonous, the red is innocuous.

250. *How may yellow phosphorus be pulverized?*

By melting it under H_2O , and agitating the mixture until it has cooled so far that the phosphorus has solidified in a finely divided form.

251. *How is red P prepared?*

By maintaining the yellow variety at from 240° (464° F.) to 280° (536° F.) in an atmosphere of carbon dioxide for two to three days, and, after cooling, washing out the unaltered yellow P with carbon disulfid.

252. *What are the chemical characters of phosphorus?*

It combines readily with oxygen (the yellow modification at lower temperatures than the red) to form an oxid if the oxygen be dry, or an acid in the presence of moisture. It combines directly with Cl, Br, and I. It is not acted on by HCl, or by cold H_2SO_4 . It is rapidly oxidized by HNO_3 . It is an energetic reducing agent.

253. *How many varieties of phosphorus poisoning may occur, and what are they?*

Two. 1st, The acute form, consequent upon the ingestion of a poisonous dose of the element; and 2d, The chronic form (also known as the lucifer disease), affecting those engaged in certain branches of match manufacture.

254. *How does the acute form occur?*

The recorded cases are about equally divided

between accidental, suicidal, and murderous. The substances used being either match heads (which are composed, in the common sulfur match, of potassium chlorate, fine sand, phosphorus, and a coloring matter), or a rat poison, which is a mixture of phosphorus with flour.

255. *What circumstances affect the rapidity with which symptoms appear in these cases?*

The action is much accelerated by the presence of any oily or fatty matter, which dissolves the poison and thus favors its absorption. The symptoms usually make their appearance within two or four hours after ingestion of the poison, but they may be delayed for days.

256. *Describe the prominent symptoms in acute phosphorus poisoning.*

Eructation of gas having the odor of garlic. The mouth, when observed in the dark, is frequently faintly luminous (phosphorescent). After several hours, pain in the throat, a sense of heat in the epigastrium, nausea, and vomiting. The vomited matters are sometimes bloody, and frequently (see Q. 261) luminous when agitated in the dark. The abdomen is tender, and there are diarrhoea and colicky pains. After one or two days these symptoms cease, there remaining only pain in the back and limbs and a feeble pulse. Death sometimes occurs suddenly in from two to four days. Usually about the fourth day the patient becomes jaundiced, suffers from headache, insomnia, and retention of urine, rapidly becomes delirious and comatose, and dies.

257. *What is the lethal dose of phosphorus?*

The smallest quantity of P that has been

known to cause the death of an adult was 0.008 gram ($\frac{1}{8}$ grain).

258. *What treatment is to be followed?*

The unabsorbed portion is to be removed as speedily as possible by an emetic of copper sulfate, or the stomach pump. No chemical antidote is known. French oil of turpentine (the older the better) should be given as a physiological antidote. The food should be entirely free from oils and fats.

259. *What post-mortem appearances are observed after death by acute phosphorus poisoning?*

Occasionally small fragments of P may be detected, by their luminous appearance, in the stomach or intestines. The œsophagus, stomach, and intestines are frequently marked with ecchymotic spots. Advanced fatty degeneration is observed in the liver, kidneys, heart, and muscular tissue. The blood is very fluid, and the red corpuscles more transparent than normal.

260. *Describe Mitscherlich's process for detecting phosphorus.*

This process is based upon the property of unoxidized phosphorus of becoming luminous in the dark. The matters supposed to contain the poison are rendered fluid by dilution with water, and acidulated with sulfuric acid. They are placed in a flask upon a sand bath, and the flask connected with a Liebig's condenser, which is placed in absolute darkness. Upon heating the flask any phosphorus present is volatilized, and, condensing in the tube, forms a luminous ring. This reaction is very delicate, and the appearance

of the ring is proof positive of the presence of unoxidized phosphorus.

261. *Under what conditions will this process fail?*

The presence of certain volatile substances destroys the luminosity of phosphorus; prominent among these are alcohol, ether, and oil of turpentine. In the case of the former two, which are quite volatile, the luminous ring does not appear until they have distilled over and are thus separated. When oil of turpentine is present the luminous property of phosphorus is permanently destroyed; consequently, when it is known that this substance has been administered, this process should not be resorted to, and in any case only half the material should be used.

(See Manual, pp. 114-117.)

262. *Give a short description of the process of match manufacture.*

The wooden splints are dipped for about a third of their length in some combustible substance, as melted sulfur or paraffin; after this has set they are pointed with the phosphorus paste. This paste is spread out on an iron plate, which is warmed. During the process (when the mixture does not fire, which frequently occurs) fumes of the lower oxids of phosphorus are given off. After the pointing process, the matches are arranged in the drying room, from which they are taken to be packed.

263. *What classes of operatives are liable to the lucifer disease?*

Those who are engaged in the manufacture of phosphorus are not attacked by it, but those who are engaged in the pointing, drying, and

packing of matches. Weak and scrofulous females and children are more subject than others.

264. *How may this form of poisoning be diminished in frequency, and prevented?*

1st. Strict cleanliness and good ventilation of the shop are imperative. 2d. The mouth is frequently washed with a weak solution of sodic carbonate. 3d. Saucers filled with turpentine are placed in the rooms. There is only one method, however, of completely remedying the evil, and at the same time preventing the daily household use of a violent poison—that is, the prohibition of the use of yellow phosphorus in the manufacture of matches.

265. *What is the composition of gaseous hydrogen phosphid?*

PH_3 .

266. *How may it be prepared?*

By the action of concentrated solution of caustic potash upon phosphorus, or by the decomposition of a compound of phosphorus and calcium by water.

267. *What are the properties of the gas as thus obtained?*

It is colorless and has a disgusting odor of rotten fish; almost insoluble in water, easily soluble in alcohol or ether. As each bubble of the gas comes in contact with the air it inflames and produces a ring of smoke. It is highly poisonous.

268. *What other substance is present in the gas as thus obtained, and what property is due to its presence?*

It is contaminated with small quantities of an-

other compound of phosphorus and hydrogen, which is liquid at ordinary temperatures. It is to the presence of this substance that the gas owes the property of igniting on contact with air. The pure gas only ignites when heated to 100° (212° F.).

269. *How many compounds of phosphorus and chlorin are known, and what are they?*

Two :

Phosphorus trichlorid, $P^{III}Cl_3$,

Phosphorus pentachlorid, $P^{V}Cl_5$.

PCl_3 is a colorless liquid, formed by the direct union of chlorin and phosphorus. When the chlorin is in excess the solid PCl_5 is formed.

270. *What compounds of phosphorus and oxygen are known?*

Two :

Phosphorus trioxid, P_2O_3 ,

Phosphorus pentoxid, P_2O_5 .

271. *Under what other name is P_2O_3 known, how is it formed, and what are its properties?*

Phosphorous anhydrid. It is formed when phosphorus is oxidized in a very limited quantity of perfectly dry air or oxygen. As soon as it is exposed to air containing a small quantity of moisture, it ignites from the heat produced by its union with H_2O , to form phosphorous acid.

272. *What is another name for P_2O_5 , and how is it formed?*

Phosphoric anhydrid. It is formed when phosphorus is burned in dry air or oxygen.

273. *What are its properties?*

It is a snowy-white, flocculent powder, having

a tendency to unite with water, which it absorbs from other substances greedily (owing to this property it forms a valuable drying agent), forming a highly acid liquid.

274. *Give the names and formulæ of the acids containing phosphorus.*

Hypophosphorous acid, H_3PO_2 ; Phosphorous acid, H_3PO_3 ; Phosphoric acid, H_3PO_4 ; Pyrophosphoric acid, $\text{H}_4\text{P}_2\text{O}_7$; Metaphosphoric acid, HPO_3 .

275. *What are the basicities of these acids?*

Hypophosphorous acid is monobasic; phosphorous acid, dibasic; phosphoric, tribasic; pyrophosphoric, tetrabasic; and metaphosphoric, monobasic.

276. *Write the formulæ of the sodium (univalent) salts of the phosphorus acids.*

NaH_2PO_2 ; NaH_2PO_3 ; Na_2HPO_3 ; NaH_2PO_4 ; Na_2HPO_4 ; Na_3PO_4 ; $\text{NaH}_3\text{P}_2\text{O}_7$; $\text{Na}_2\text{H}_2\text{P}_2\text{O}_7$; $\text{Na}_3\text{HP}_2\text{O}_7$; $\text{Na}_4\text{P}_2\text{O}_7$; NaPO_3 .

277. *How does phosphoric acid occur in nature?*

It is not found free, but is very widely disseminated in combination in the phosphates, in the mineral, vegetable, and animal world.

278. *By what other names is it known?*

Common phosphoric acid or tribasic phosphoric acid.

279. *How is it prepared?*

By the direct oxidation of P by means of HNO_3 . The reaction, which is dangerous when yellow P is used, is started by the application of heat, and, once started, continues without further heating.

280. *What is the Acidum phosphoricum dilutum, U. S., Br.?*

A solution of phosphoric acid, prepared as above, diluted with water to sp. gr. 1.056, and containing 10 per cent. of acid, U. S.; sp. gr. 1.08 = 14 per cent. of acid, Br.

281. *By what tests may phosphoric acid or a phosphate in solution be detected?*

1. Add solution of ammonium chlorid, containing free ammonia, and then solution of magnesium sulfate; if H_3PO_4 be present, a white crystalline precipitate is formed

[The same reaction occurs if an arsenate be present.]

2. To the neutral solution add solution of silver nitrate; if H_3PO_4 be present, a yellowish-white precipitate is formed, which dissolves on addition of HNO_3 or of ammonium hydroxid. [If the precipitate were formed by an arsenate, it would not be yellowish, but brown or brick red.]

3. To dilute HNO_3 , add the solution to be tested, and then solution of ammonium molybdate; if H_3PO_4 be present, a yellowish precipitate is formed.

ARSENIC.

282. *Give the symbol, and atomic and molecular weights of arsenic.*

Symbol — As. Atomic weight = 75. Molecular weight = 300.

283. *Of how many atoms is the molecule of arsenic composed?*

Of four.

284. *How does arsenic exist in nature?*

In small quantities in the elementary form ; more abundantly in three sulfur compounds, realgar, orpiment, and mispickel, the last being a compound of sulfur, arsenic, and iron, and the chief ore of arsenic. It also exists in small quantities in many ores, and in traces in the waters of certain mineral springs.

285. *What are the properties of arsenic?*

It is a gray solid. When pure it is odorless and tasteless ; easily powdered ; sp. gr. 5.6 to 5.9 ; when heated to 180° (356° F.) without access of air, it distils unchanged and without melting. It is a good conductor of electricity.

286. *What action have air and water upon As?*

At ordinary temperatures it remains unchanged in dry air ; at high temperatures it unites rapidly with O, producing a strong bluish-white light. When pure it is insoluble in H_2O , but when exposed to that fluid or to damp air it becomes tarnished from the formation of a film of oxid upon its surface, and this oxid is dissolved to a certain extent by the H_2O .

287. *For what purposes is arsenic used in the arts?*

It is mixed with lead in the manufacture of shot : it enters into the composition of fly poison, and is used in certain fireworks.

288. *What compound of arsenic and hydrogen is known?*

Hydrogen arsenid, AsH_3 .

289. *Under what conditions is this substance formed?*

When nascent hydrogen is in presence of an arsenical compound.

290. *What are its physical properties?*

A colorless gas, having a strong odor of garlic, soluble in five volumes of air free H_2O ; burns in air.

291. *How is it affected by red heat in the absence of air?*

It is decomposed into its constituent elements, As being deposited as a brilliant metallic solid, and H passing off as gas.

292. *What is produced when AsH_3 is burnt in air?*

If the flame be not interfered with, the combustion is complete, the H forming H_2O , and the As, As_2O_3 . The latter may be condensed on a cold surface held above the flame, in the form of white octahedral crystals.

If the flame be cooled by introduction into it of a cold surface, the oxidation is limited to the formation of H_2O , and elementary As is deposited upon the cold surface as a brown, or dark gray, film.

293. *What changes are caused by passing AsH_3 through a solution of silver nitrate?*

The solution is darkened, and deposits a black sediment of metallic silver. Arsenious acid is produced, and remains in the solution.

294. *Name the compounds of arsenic and oxygen.*

Arsenic trioxid, As_2O_3 .

Arsenic pentoxid, As_2O_5 .

295. *Under what other names is arsenic trioxid known?*

Arsenious anhydrid, white arsenic, and, im-

properly, as arsenious acid ; Acidum arseniosum, U. S., Br.

296. *What are the physical properties of As_2O_3 ?*

It occurs in two forms : 1st. As "flowers of arsenic," a heavy, white, crystalline powder, usually in octahedra, sometimes in prisms ; sp. gr. 3.69. 2d. An amorphous substance, either translucent and yellowish (vitreous arsenic) or white and opaque (porcelainous arsenic) ; sp. gr. 3.79. Both forms are odorless and have a faint, somewhat metallic taste when in solution.

297. *Describe and explain what is observed when powdered white arsenic is thrown on water.*

Notwithstanding its high sp. gr., a portion only sinks, the remainder floating on the surface. The particles of the portion which sinks are no longer distinct, but are collected in lumps, each of which encloses a bubble of air. The floating particles also have air bubbles adherent to them. A film of air therefore adheres to the surface of the arsenic and prevents its contact with the water.

298. *What is the solubility of white arsenic in pure water?*

The vitreous variety is more readily and more rapidly soluble than the crystalline, but by prolonged boiling the solubilities of the two become more nearly equal. Even after long contact with a large excess of cold H_2O all of the crystalline arsenic is not dissolved. One thousand parts of cold H_2O , in contact with powdered white arsenic for twenty-four hours, dissolve about two parts of the oxid. The same amount of boiling H_2O , put upon the powder and allowed

to stand twenty-four hours, dissolves about 10 parts, and the same amount of H_2O , boiled on the powder for one hour (the amount of liquid being kept the same), dissolves about 65 parts. A hot saturated solution may be evaporated to half its bulk without depositing any of the oxid, and, if allowed to cool, it still retains a large amount.

299. *How is the solubility of white arsenic in water influenced by the presence of other substances?*

The presence of mineral acids, or alkalies, ammonia, ammoniacal salts, alkaline carbonates, tartaric acid, or tartrates increases the solubility. Fats and other organic substances (present in the various liquid articles of food) diminish the solubility.

NOTE.—In medico-legal cases it must not be forgotten that a poisonous substance may be swallowed with a drink, without being in solution. If the beverage be mucilaginous, or be stirred immediately before drinking, the amount held in suspension may greatly exceed that held in solution.

300. *If As_2O_3 be heated in a tube, what occurs?*

It volatilizes unchanged, and is deposited in the cool parts of the tube in the form of small, brilliant, white, eight-sided crystals.

301. *If As_2O_3 be heated in the presence of charcoal, what occurs?*

It gives up its oxygen readily; carbonic anhydrid is formed, while arsenic is deposited in the elementary form.

302. *How does As_2O_3 behave with oxidizing agents?*

It takes up oxygen readily. In aqueous solu-

tion, exposed to the air, a portion is converted into H_3AsO_4 . With HNO_3 the action is more rapid, H_3AsO_4 being formed, while brown fumes are given off.

303. *What action has hydrogen sulfid on As_2O_3 in acid solution?*

Both substances are decomposed, the trisulfid of arsenic, As_2S_3 , being deposited as an insoluble yellow powder.

304. *For what purposes is As_2O_3 used in the arts?*

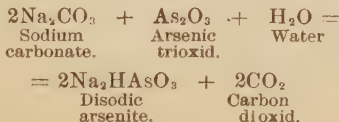
In the manufacture of green pigments; of opaque white glass; in calico printing; in the preservation of animal substances by the taxidermist and for dissection; as a vermin poison; and as the starting-point in the manufacture of arsenical compounds.

305. *What is the true arsenious acid?*

This substance has not been isolated, but is considered as existing in solutions of arsenious anhydrid, and having the formula H_3AsO_3 (corresponding to that of phosphorous acid). There are, however, a number of important salts corresponding to this acid, known as arsenites.

306. *What is produced when a solution of sodium carbonate is heated with white arsenic?*

A solution of sodium arsenite. Carbon dioxide is given off



307. *What is Fowler's solution?*

A solution of potassium arsenite in water, containing compound tincture of lavender to give it taste and odor, that it may not be mistaken for water.

308. *What is Scheele's green?*

Arsenite of copper.

309. *What is Schweinfurt green?*

A compound of arsenite and acetate of copper; aceto-metarsenite of copper.

310. *Under what name is Schweinfurt green known in the U. S.?*

Paris green.

311. *What is another name for arsenic pentoxid, and what are its properties?*

Arsenic anhydrid. It is a heavy, white solid, gradually but abundantly soluble in water.

312. *What is produced when As_2O_5 is dissolved in H_2O ?*

An acid solution of arsenic acid, H_3AsO_4 .

313. *What phosphorus acid does arsenic acid resemble in its chemical properties?*

Phosphoric acid. It is converted into pyroarsenic and metarsenic acids under the same conditions under which phosphoric acid yields pyrophosphoric and metaphosphoric acids. Its salts, called arsenates, resemble in constitution the corresponding compounds of phosphoric acid.

314. *What is realgar, and how does it occur?*

Arsenic disulfid, As_2S_2 . It is found in nature in translucent red crystals. It is also manufactured commercially by melting together arsenic trioxid and sulfur; and, thus prepared, it forms dark-red amorphous masses, tasteless and odor-

less. In powder it is orange-yellow, insoluble in water, alcohol, or dilute hydrochloric acid.

315. *How do the natural and artificial realgars differ in their action when taken internally, and why?*

The native realgar is inert, while the artificial product is poisonous. The sulfid is in both cases non-poisonous, but the artificial realgar always contains arsenic trioxid.

316. *What is the common name for arsenic trisulfid, and how does it occur?*

It is found in nature as brilliant, yellow, gold-like scales and crystals, known as *orpiment*. It is also manufactured artificially by subliming together arsenic trioxid and sulfur; this product, used as a pigment under the name *King's yellow*, always contains arsenic trioxid, which renders it more poisonous than orpiment. Pure As_2S_3 may be obtained by passing hydrogen sulfid through an acid solution of arsenic trioxid and washing the deposit.

317. *What relation has As_2S_3 to As_2O_3 chemically?*

As As_2O_3 is the anhydrid of arsenious acid, so As_2S_3 is the anhydrid of an acid of similar composition, in which the oxygen is replaced by sulfur, called thioarsenious acid, AsS_3H_3 , and corresponding to which are salts, called thioarsenites.

318. *What other compound of sulfur and arsenic is known?*

Arsenic pentasulfid, As_2S_5 .

319. *What is Donovan's solution?*

A solution of mercuric iodid and arsenious iodid, AsI_3 .

320. *Name some of the compounds of arsenic which have given rise to poisoning.*

Elementary arsenic, hydrogen arsenid, arsenic trioxid, potassium or sodium arsenite, artificial sulfids of arsenic, arsenical greens.

321. *In what way may elementary arsenic cause poisoning?*

By the ingestion of fly paper, or the H_2O in which it has been moistened. The As with which the paper is charged is converted into H_3AsO_3 by the action of air and moisture.

322. *How has As H_3 caused poisoning?*

By inhalation of H made from Zn and H_2SO_4 containing As.

323. *Which of the arsenical compounds has been the most frequently administered with homicidal intent?*

Arsenic trioxid.

324. *By what channels has it been so administered?*

By the mouth, by injection into the rectum and into the male urethra, by the vagina.

325. *Have fatal cases of arsenical poisoning resulted from the external application of arsenical compounds?*

Yes, numerous cases are recorded resulting from the rubbing of arsenical preparations into the scalp, scrotum, etc., to kill parasites, as well as by the use of such preparations by quacks as cancer cures.

326. *What is the lethal dose of white arsenic?*

The smallest amount known to have caused the death of an adult was 0.162 gram ($2\frac{1}{2}$ grains).

A case is recorded in which 62 grams ($\frac{7}{8}$ ij.) were taken without causing death.

327. *State the conditions which favor the activity of the true poisons.*

1. When taken in solution, or in a form readily dissolved by the gastric secretions. 2. When vomiting does not occur, or is delayed. 3. When taken into the empty stomach with little or no solid food. 4. When the person exercises actively after the poison has been taken. 5. When taken into a system already weakened by disease.

328. *State the conditions which impede the action of the true poisons.*

1. When taken in a form insoluble either by reason of chemical combination or physical condition. 2. When vomiting is copious and occurs early. Almost the entire quantity taken may be thus expelled before absorption has occurred to any great extent. 3. Sleep. 4. When taken by a person already under the influence of a drug having antagonistic action. 5. When taken by one habituated to its use.

329. *In what way may the arsenical pigments give rise to accidental poisoning?*

By inhabiting rooms the walls of which are covered with paper colored by these substances; by the use of articles of clothing or ornament dyed with them; by sucking ornamental confectionery of a green color; and by the accidental mixing of Paris green, used to exterminate vermin, with articles of food.

330. *What are the prominent symptoms of acute arsenical poisoning?*

They usually begin in from 20 to 45 minutes.

Nausea and faintness. Violent, burning pain in the stomach, which becomes more and more intense, and increases on pressure. Persistent and distressing vomiting of matters, sometimes brown or gray, or streaked with blood, or green (Paris green), or black or blue (charcoal or indigo powder mixed with As_2O_3 according to the English law). Purging. More or less severe cramps in the lower extremities.

331. *What are the prominent symptoms of chronic arsenical poisoning?*

Inflammation of the conjunctivæ, with intolerance of light. Irritation of the skin, accompanied by an eruption (eczema arsenicale). Local paralyses. Great weakness and emaciation. Exfoliation of the cuticle and falling out of the hair.

332. *What should the treatment be in acute arsenical poisoning?*

If vomiting have not occurred, it should be induced by tickling the fauces or by zinc sulfate, never by tartaremetic; the stomach pump should be used if the case be seen early. Moist, recently prepared ferric hydroxid, or "dialyzed iron," should be administered.

333. *How is ferric hydroxid prepared for this purpose?*

Add to solution of ferric sulfate (Liq. ferri tersulfatis, U. S.; Liq. ferri persulfatis, Br.) excess of aqua ammoniæ, collect upon muslin, and wash with water. It should be prepared when wanted, and administered, while still moist, in doses twenty times as great as the amount of arsenic presumed to have been taken.

334. *What test should be applied to the urine during life to detect the presence of arsenic?*

Reinsch's test (see Q 346-348).

335. *When should this test not be used, and why?*

It should not be applied to any portion of the body after death in a case of suspected homicide, until the presence of arsenic has been demonstrated by other tests, and until after the relative amounts of As and Cu have been determined. If this precaution be neglected, Cu is introduced into the substances under examination, and the distinction between As_2O_3 and Paris green becomes impossible.

336. *Describe the post-mortem appearances in acute arsenical poisoning.*

They are confined to the stomach and intestines. The stomach is inflamed, whether As has been taken by the mouth or by other channels of absorption. The mucous surface is coated with a layer of mucus, tinged with blood or bile, and sometimes containing white crystals of As_2O_3 or green particles of Paris green. The color of the mucous membrane is brownish red, interspersed with darker streaks or patches between the rugæ. The small intestines are sometimes inflamed throughout their length, but more usually the inflammation is limited to the duodenum.

337. *Is the above appearance of the stomach positive proof that the poison was taken during life?*

It is not. When As_2O_3 is injected into the stomach after death, the walls of the viscus become reddened so as closely to simulate the appearance of inflammation.

338. *What portions of the cadaver should be preserved for analysis in cases of suspected homicide by poison?*

The alimentary canal from the cardia to the middle of the rectum, *unopened*, and the contents enclosed by ligatures at the œsophagus, duodenum, and lower end of gut; the liver, including the gall bladder; one kidney; the spleen; a piece of muscular tissue; the brain, and any urine which may remain in the bladder.

Any suspected food articles, and any obtainable vomited matter, are to be also preserved.

339. *How should these parts be preserved?*

They are to be placed in *clean* and *new* glass jars, closed with glass or cork covers or stoppers. Jars with metallic caps should never be used. Tapes or cords should be tied about the jar and cap, to which they should be attached by sealing wax bearing impressions of a seal, in such a manner that access can only be had to the interior after breaking the seals or cutting the tapes or cords. Great care must be exercised that no sealing wax can get into the jars. Each portion should be placed in a jar by itself.

340. *What should be particularly noted in examining the cadaver superficially?*

The presence or absence of incisions of the course of the arteries, particularly brachials, femorals, and carotids, as indicating whether or no the body has been embalmed.

341. *How may solutions of arsenious and arsenic acids be distinguished from each other?*

By solution of nitrate of silver, in presence of ammonia. With solution of arsenious acid

silver arsenite is formed as a yellow precipitate, while with solution of arsenic acid silver arsenite is formed as a chocolate-brown precipitate.

342. *Upon what reactions is Marsh's test for arsenic based?*

1. When nascent H is formed in presence of an arsenical compound, AsH_3 is produced.

2. When AsH_3 is passed through a red-hot tube, it is decomposed into As and H.

3. When AsH_3 is burned, and a cold surface held *above* the flame, As_2O_3 is deposited in octahedral crystals.

4. When AsH_3 is burned, and a cold surface held *in* the flame, As is deposited as a brown or black stain.

5. When AsH_3 is passed into a solution of silver nitrate, metallic Ag is deposited and the solution contains H_3AsO_2 .

6. When As is heated in a current of air, it disappears and octahedral crystals of As_2O_3 are formed.

(See Manual, pp 133-135.)

343. *What substance may be mistaken for arsenic by this test?*

Antimony, which under the same conditions produces stains and mirrors closely resembling those of arsenic.

344. *How may the two substances be distinguished?*

By gently heating the deposit in one of the tubes, when it disappears rapidly, and octahedral crystals are formed if it be As.

It requires a higher degree of heat to cause the disappearance of the antimonial deposit, and the

white sublimate into which it is converted is not crystalline.

(See Manual, p. 134.)

345. *Describe Reinsch's test for arsenic.*

Add to the suspected fluid one-sixth its volume of pure hydrochloric acid ; suspend in the fluid a piece of bright electrottype copper, and boil. If a steel-gray deposit form on the copper, remove the copper with its adhering deposit, wash it with pure water, and dry between folds of filter paper, being careful not to rub off the deposit. Coil up the copper and put it into a clean, dry tube, open at both ends, holding the tube at such an angle that the spiral does not slip out ; apply heat at the part containing the copper.

346. *What other substances produce deposits similar to those of arsenic, and how may they be distinguished ?*

Antimony, mercury, bismuth, gold, and platinum. If either of these be present, a gray or black deposit is formed on the copper. If the deposit be arsenic, there will form in the cold part of the tube, during heating of the part containing the copper, a white deposit, composed of small octahedral crystals of arsenic trioxid ; if antimony, a white sublimate will form, which is either entirely amorphous, or amorphous for the most part, containing a few crystals, either octahedra, not so brilliant as those of As_2O_3 and nearer to the heat, or prisms in that part of the tube which was in the flame ; if bismuth, platinum, or gold, no sublimate will be formed ; and if mercury, there will form a deposit of metallic mercury in small, brilliant globules.

347. *What precautions are to be observed in this test?*

Be sure of the purity of the copper and hydrochloric acid used ; perform a blank testing with samples of the hydrochloric acid, copper, and water, under the same conditions as the actual test. Use only a small piece of copper at the beginning ; when a deposit has formed on that, remove it and substitute another, and so on until all the arsenic present has been collected.

348. *When is Reinsch's test not applicable?*

When arsenic is present in the form of arsenic acid or an arsenate ; in this case the deposit is formed but slowly, if at all. When it is suspected that the substance present is an arsenate, it should be reduced to an arsenite by sulfurous acid before applying Reinsch's test. The test cannot be applied in the presence of oxidizing agents, such as free nitric acid, potassium chlorate, nitrates in large quantity, etc. On the other hand, this test is the only one that can be applied directly to fluids containing organic matter.

NOTE. In testing the urine it may safely be considered that if arsenic be present it will be as arsenite and not as arsenate.

349. *What reaction takes place when H_2S is passed through alkaline and acid solutions of arsenious acid or the arsenites?*

If the solution be alkaline it becomes yellow ; if acid, a precipitate of yellow arsenic trisulfid is formed.

350. *What reaction occurs when a cold solution of an arsenate is treated with H_2S ?*

The arsenate is first reduced to arsenite, with deposition of sulfur; subsequently the yellow precipitate of As_2S_3 is slowly formed. The complete separation of the As in this case requires several days.

351. *Describe the reduction test for arsenic.*

Place the solid to be examined in the closed end of a small tube, and above it a fragment of charcoal; heat the charcoal to redness and then heat the solid under it. In the presence of As a brilliant metallic "mirror" is formed in the tube. The materials and tube must be perfectly dry.

352. *Describe the sublimation test for As_2O_3 and Paris green.*

Heat the suspected powder in a small tube closed at one end; crystals of As_2O_3 are formed in the cool part of the tube.

353. *Describe the copper test for arsenic.*

Add solution of cupric sulfate, to which ammonium hydroxid has been added until the precipitate formed just redissolves, to the suspected liquid; a green precipitate is formed if the reaction be neutral.

354. *What treatment must organic fluids be subjected to before testing for mineral poisons?*

The organic matter must be destroyed, as it interferes with the reactions to such an extent that, in fluids containing organic matter, it is impossible to be certain of the presence or absence of poisonous mineral matter. (See Manual, p. 136.)

ANTIMONY.

355. *What are the symbol and atomic weight of antimony?*

Symbol = Sb (from the Latin: Stibium).
Atomic weight = 120.

356. *What are its physical properties?*

It has a metallic appearance, crystalline texture, is tasteless, odorless, brittle, and easily pulverized; it melts at 450° (842° F.), and crystallizes on cooling; it may be distilled unchanged when air is excluded, but when sufficiently heated in air it burns brilliantly.

357. *What is the chief ore of antimony?*

The trisulfid, Sb_2S_3 , known commercially as *black antimony* or *crude antimony*, and pharmaceutically as *Antimonii sulfidum*, U. S.; *Antimonium nigrum*, Br.

358. *For what purposes is antimony used in the arts?*

It enters into the composition of a number of important alloys: type metal is an alloy of lead, tin, and antimony; britannia metal and the various antifriction alloys contain antimony. Its value in these alloys is, that it renders them hard and communicates the property of expanding on solidifying.

359. *What compound of antimony and hydrogen is known, and what are its properties?*

Hydrogen antimonid, or antimoniuiretted hydrogen, SbH_3 , having a composition corresponding to the hydrogen compounds of nitrogen, phosphorus, and arsenic. It is a colorless gas, resembling hydrogen arsenid in its properties and

decompositions, except in that it is but slightly poisonous.

360. *What is butter of antimony, and what are its physical properties?*

It is the trichlorid, SbCl_3 , and forms at ordinary temperatures a semi-solid, yellow, crystalline mass, which fuses at 73° (164° F.), and boils at 223° (433° F.). When exposed to the air it absorbs moisture and becomes first cloudy, then dark and oily.

361. *What is the action of H_2O upon antimony trichlorid?*

When diluted with H_2O it is decomposed, and a white, insoluble precipitate is formed. This was formerly known as *powder of Algaroth*, and is an oxychlorid of antimony.

362. *How is the Antimonii oxidum, U. S., Br., prepared, and what is its composition?*

By decomposing the oxychlorid, obtained by the reaction given in 361. It is the trioxid, Sb_2O_3 .

363. *What substance is formed when hydrogen sulfid is passed through a solution of an antimonial compound?*

Antimony pentasulfid, Sb_2S_5 . This is the "golden sulfuret of antimony." It is an orange-colored, amorphous powder, readily soluble in ammonium sulfhydrate solution and in hot HCl , but insoluble in ammonium hydroxid solution.

364. *What is Kermes mineral?*

A mixture, in varying proportions, of the sulfids and trioxid of antimony. (See Q. 929, 930.)

(For analytical reactions of Sb see Manual, pp. 134, 141; and Laboratory Guide, pp. 18, 86.)

BORON.

365. *What are the symbol, atomic weight, and valence of boron?*

Its symbol is B ; its atomic weight, 11. It is trivalent in all of its compounds.

366. *What is the most important compound of boron?*

Boric acid— H_3BO_3 —Acidum boricum, U. S.

367. *What are the properties of boric acid?*

White, glistening plates, unctuous to the touch; odorless; having a slightly bitter taste, and without corrosive or poisonous action; soluble in water. It is a valuable antiseptic. When heated to 80° (176° F.) it loses H_2O and forms metaboric acid, HBO_2 ; and at 100° (212° F.) it forms pyroboric acid, $\text{H}_2\text{B}_4\text{O}_7$, whose sodium salt is borax.

GROUP V. CARBON GROUP.

CARBON	C.....	12.
SILICON	Si.....	28.

368. *State the common characters of the elements of this group.*

They are bivalent and quadrivalent. They are combustible. Each exists in three allotropic forms. Their saturated oxids are anhydrids of dibasic acids.

CARBON.

369. *What are the symbol and atomic weight of carbon?*

Its symbol is C, and its atomic weight is 12.

370. *How does carbon exist uncombined in nature?*

1. Almost pure, crystallized, as diamond.
2. Nearly pure, but less so than in diamond, as graphite or "black lead."
3. Mixed with more or less impurity, as the various kinds of coal.

371. *Name some of the artificial products composed almost entirely of carbon.*

1. Charcoal, obtained by subjecting wood to heat, with a limited supply of air.
2. Lamp-black, obtained by the incomplete combustion of substances rich in carbon, such as resin, natural

gas, etc. 3. Coke, a porous substance remaining after heating certain kinds of coal without contact with air. 4. Animal charcoal, obtained by subjecting animal matter to heat in closed vessels ; contains a large amount of mineral salts or ash.

372. *State the properties and uses of animal charcoal.*

It possesses the power of absorbing coloring matters and other substances from solutions. It is used in the refining of cane-sugar to remove the coloring matter, and for the same purpose in various pharmaceutical and chemical operations. Care must be had, however, that loss be not sustained from the absorbing action of the charcoal on other substances, such as the alkaloids and various vegetable principles. Indeed, purified animal charcoal has been used to separate alkaloids from solutions in which they are mixed with other substances. The deodorizing power of the crude charcoal is greater than that of the purified. The latter is to be used in the presence of any substance capable of acting on the mineral ingredients of the crude charcoal, notably in the presence of acids. (See Q. 573.)

373. *What is the action of oxygen upon carbon at high temperatures ?*

The two elements have a great tendency to unite with each other, with liberation of heat and light. If the supply of O be sufficient, an invisible compound, having the composition CO_2 , is formed ; while if the supply of O be insufficient, another gas, CO, is formed.

374. *What are the compounds of carbon with other elements called?*

Organic substances.

(For COMPOUNDS OF CARBON, see p. 171 et seq.)

SILICON.

375. *What are the symbol and atomic weight of silicon?*

Its symbol is Si ; its atomic weight 28.

376. *Name some important compounds of silicon.*

Silicic anhydrid, or silicon dioxid, SiO_2 , and the corresponding acid, H_4SiO_4 .

377. *How do these substances exist in nature?*

They are very abundant. Silicic anhydrid exists nearly pure as rock crystal, and less pure in the quartz entering into the composition of various rocks, sand, sandstone, and in a vast number of minerals. Silicic acid in combination, *i.e.*, silicates, constitutes a great number of minerals, and exists in animal and vegetable bodies and in many mineral waters.

CLASS III. AMPHOTERIC ELEMENTS.

378. *What are the characteristics of the amphoteric elements?*

Their oxids combine with water, sometimes to form acids, sometimes to form bases. They are capable of displacing the hydrogen of the oxyacids to form oxysalts.

379. *What name is used to designate the elements of this and the following class?*

The Metals.

380. *Name the principal amphoteric elements.*

Gold, chromium, manganese, iron, aluminium, lead, bismuth, tin, and platinum.

GROUP I. THE GOLD GROUP.

GOLD. Au. 197.

381. *What are the symbol and valence of gold?*

Au, from the Latin, aurum. Gold forms two series of compounds, in one of which it is univalent, as in aurous chlorid, AuCl , and in the other trivalent, as in auric chlorid, AuCl_3 .

382. *By what agents is gold attacked?*

By free chlorin or bromin, by nitro-muriatic acid, from which chlorin is liberated. Mercury dissolves gold, forming a liquid amalgam. It is not attacked by any single acid or by any alkali.

383. *What is the composition of United States gold coin?*

900 parts of gold, alloyed with 100 of copper. Jeweller's gold (18 karat) contains about $\frac{750}{1000}$ gold, the remainder being copper and silver in proportions varying with the color.

384. *What compound of gold is used in the chemical and histological laboratories?*

Auric chlorid, AuCl_3 = terchlorid of gold.

385. *Give the tests for the auric compounds.*

1. With H_2S , in neutral or acid solution, a dark-brown precipitate, insoluble in HNO_3 or in NH_4HS .

2. With stannous chlorid and a little chlorin water, a purple-red precipitate.

3. With ferrous sulfate, a dark-brown precipitate.

GROUP II. THE IRON GROUP.

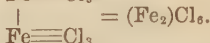
CHROMIUM	Cr	52.
MANGANESE	Mn	54.
IRON	Fe	56.

386. *Name the elements constituting the Iron group.*

Chromium, manganese, iron.

387. *What are the valences of these elements?*

They are either bivalent or quadrivalent. They form two series of compounds, in one of which the bivalent atom occurs, as in $\text{Fe}''\text{Cl}_2$ or FeO . In compounds of the second series two atoms of the quadrivalent element combine, exchanging a valence between them to form a hexavalent group, as in $\text{Fe}\equiv\text{Cl}_3$



388. *How are these two series distinguished by name?*

That containing the less proportion of the more electro-negative element or radical is distinguished by the termination *ous*; that containing the greater proportion by the termination *ic*. Thus FeCl_2 is *ferrous* chlorid, Fe_2Cl_6 *ferric* chlorid.

CHROMIUM. Cr. 52.4.

389. *Give the formula of chromic anhydrid ?*

CrO_3 . It is also known, improperly, as chromic acid—*Acidum chromicum*, U. S. P.

390. *How is it prepared, and what are its uses ?*

It is prepared by slowly adding 3 parts of sulfuric acid to 2 parts of a saturated solution of potassium dichromate ; upon cooling, a mass of dark red needles of CrO_3 separate, and are freed from excess of H_2SO_4 by draining upon a porous tile. It is one of the most active oxidizing agents we have, and, as such, is used in the laboratory, and medicinally as an escharotic. In dilute solution it is used as a hardening agent in histological laboratories.

391. *Explain the chemical difference between potassium chromate and dichromate.*

The former has the formula K_2CrO_4 , and the latter $\text{K}_2\text{Cr}_2\text{O}_7$; they are therefore not salts of the same acid, as are carbonate and bicarbonate of potassium, Na_2CO_3 and NaHCO_3 , and the name bichromate tends to mislead. The chromate is a salt of chromic acid, and the dichromate a salt of dichromic acid. From the constitution of these and other salts we may consider that chromic anhydrid is capable of forming three acids :

$\text{CrO}_3 + \text{H}_2\text{O} = \text{H}_2\text{CrO}_4 = \text{Chromic acid.}$

$2\text{CrO}_3 + \text{H}_2\text{O} = \text{H}_2\text{Cr}_2\text{O}_7 = \text{Dichromic acid.}$

$3\text{CrO}_3 + \text{H}_2\text{O} = \text{H}_2\text{Cr}_3\text{O}_{10} = \text{Trichromic acid.}$

None of these acids have been separated ; they are only known in their salts.

392. *State the properties of $\text{K}_2\text{Cr}_2\text{O}_7$.*

It forms prismatic crystals of a fine orange-red

color ; odorless ; having a bitter, acrid taste ; soluble in water. Poisonous. When mixed with sulfuric acid it forms a powerful oxidizing agent.

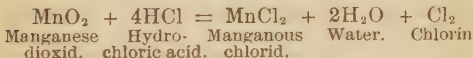
393. *What is "chrome yellow" ?*

Lead chromate, PbCrO_4 .

MANGANESE. Mn. 54.

394. *Give an account of the most important oxid of manganese.*

Manganese dioxid, MnO_2 , also known as black oxid or peroxid of manganese, is the chief ore of manganese, and is used in the arts in obtaining chlorin by the decomposition of hydrochloric acid :



When heated to redness it gives up part of its oxygen, and has been used for obtaining that element.

395. *What chemical interest has the oxid Mn_2O_7 ?*

It is an anhydrid, whose corresponding acid, $\text{H}_2\text{Mn}_2\text{O}_8$, has not been separated, but some of the salts of which, called permanganates, are of importance.

396. *Give the formula and properties of potassium permanganate.*

$\text{K}_2\text{Mn}_2\text{O}_8$. It forms slender, prismatic crystals, of a purple color with a bronze-like reflection ; inodorous, and having a sweetish, astringent taste. Quite soluble in water, the solution

having a deep purple color, and a pink color when extremely dilute.

397. *How does $K_2Mn_2O_8$ act as a disinfectant?*

It is a very active oxidizing agent, and its action as a disinfectant is due to the oxidation of the organic matter which it causes. It forms the basis of Condly's and several other disinfecting fluids.

IRON. Fe. 56.

398. *How do cast iron, wrought iron, and steel differ from each other in composition?*

Mainly in the different quantity of carbon contained. Wrought iron is made from cast iron by burning out carbon; steel is prepared from wrought iron by causing it again to combine with carbon. Wrought iron is used in obtaining pharmaceutical preparations.

399. *What is Ferrum reductum, U. S. P.?*

A pure and finely divided iron obtained by reducing (see Q. 54) an oxid of iron by hydrogen :



Reduced iron, or iron by hydrogen, as it is also called, should leave no residue when attracted by the magnet; such a residue is unreduced oxid.

400. *Give the formula and synonyms of ferric oxid.*

Fe_2O_3 . Sesquioxid of iron, peroxid of iron, red oxid of iron, colcothar, rouge, Venetian red.

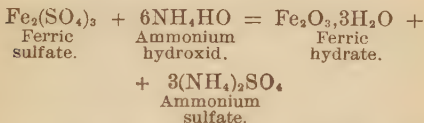
401. *What is the composition of iron rust?*

Chiefly a ferric hydrate, having the composi-

tion $2\text{Fe}_2\text{O}_3, 3\text{H}_2\text{O}$, with small quantities of the carbonate.

402. *What is Ferri oxidum hydratum, U. S. P., and how is it prepared?*

Ferric hydrate, $\text{Fe}_2\text{O}_3, 3\text{H}_2\text{O}$, prepared by adding ammonium hydroxid to solution of ferric sulfate (Liq. ferri tersulfatis, U. S. P.) :



The precipitated hydrate is collected upon a calico filter and washed.

403. *To what medical use is ferric hydrate put, and how does it act?*

As an antidote in arsenical poisoning. By producing the insoluble ferric arsenite.

404. *What decomposition occurs when this product is dried?*

It loses two molecules of water, and is converted into the hydrate, $\text{Fe}_2\text{O}_3, \text{H}_2\text{O} = \text{Ferri peroxidum hydratum, Br.}$

405. *Give the formula, method of preparation, and use of ferrous sulfid.*

FeS . It is prepared by heating together sulfur and iron filings, and is used in the laboratory to obtain hydrogen sulfid.

406. *Give the formula and synonyms of ferric chlorid.*

Fe_2Cl_6 . Ferri chloridum, U. S., Br. Sesquichlorid of iron, perchlorid of iron.

407. *Give the U. S. P. method of its preparation.*

Iron is dissolved in hydrochloric acid, when ferrous chlorid, FeCl_2 , is formed. This is then boiled with nitric acid and excess of hydrochloric acid, by which FeCl_2 is converted into Fe_2Cl_6 . As thus prepared it always contains an excess of acid.

408. *How may neutral ferric chlorid be obtained?*

By heating iron in a current of chlorine, Fe_2Cl_6 condenses in the cool part of the tube.

409. *Give the formula and synonyms of ferrous sulfate.*

FeSO_4 . Ferri sulfas, U. S., Br. Sulfate of iron, green vitriol, copperas.

410. *State the method of its preparation and its properties.*

It is prepared by dissolving iron in dilute sulfuric acid and evaporating the solution to the point of crystallization. It forms apple-green crystals, containing 7Aq, odorless, having a sweetish, styptic taste, very soluble in water, insoluble in alcohol.

411. *Give the analytical characters of the ferrous salts.*

1. With potassium hydroxid, a greenish precipitate, insoluble in excess, and turning darker green and brown on exposure.

2. With potassium ferrocyanid, a white precipitate, turning blue on exposure.

3. With potassium ferricyanid, a dark blue precipitate.

412. *Give the analytical characters of the ferric salts.*

1. With potassium hydroxid, a voluminous, red-brown precipitate.

2. With H_2S in acid solution, a milky precipitate of elementary sulfur.

3. With potassium ferrocyanid, a dark blue precipitate, insoluble in HCl , soluble in KHO .

4. With potassium (or ammonium) thiocyanate, a deep red color, discharged on addition of mercuric chlorid solution.

413. *What is produced on addition of ammonium sulphhydrate solution to a solution of a ferrous or ferric salt?*

A black precipitate of ferric sulfid, readily soluble in HCl .

414. *What are Prussian blue and Turnbull's blue?*

Prussian blue is ferric ferrocyanid, obtained by adding potassium ferrocyanid solution to a solution of a ferric salt (3, Q. 412). Turnbull's blue is ferrous ferricyanid, obtained by precipitating a solution of a ferrous salt with potassium ferricyanid (3, Q. 411).

GROUP III. THE ALUMINIUM GROUP.

GLUCINIUM	Gl	9
ALUMINIUM	Al	27
SCANDIUM	Sc	45
GALLIUM	Ga	69
INDIUM	In	113

415. *What are the common characters of the elements of this group?*

They form but a single series of compounds and salts, corresponding to the *ic* series of the preceding group, each of which contains a double atom of the element, behaving as a hexavalent group. No compounds corresponding to the *ous* series of the second group are known. In other respects the terms of this group resemble those of the preceding closely.

ALUMINIUM. Al. 27.5.

416. *What is a notable physical property of aluminium?*

Its great lightness. Of all the metals it is the lightest, with the exception of the metals of the alkalis, which latter, however, cannot be kept unaltered in air. Aluminium is also quite tough, and is very useful in the manufacture of metal appliances where lightness is an object.

417. *How does aluminium exist in nature?*

It is one of the most abundant of the elements. Its oxid, Al_2O_3 , exists nearly pure as corundum, ruby, and sapphire, and in a less pure form as emery. Its silicate, combined with other silicates, forms the different varieties of clay, mica, feldspar, etc.

418. *Explain the constitution of an alum.*

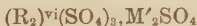
The sulfate of aluminium, in common with ferric, manganic, and chromic sulfates, possesses a great tendency to combine with the sulfates of potassium, sodium, and ammonium, to form definite double salts, which are called alums. Thus we have :

$\text{Al}_2(\text{SO}_4)_3, \text{K}_2\text{SO}_4 = \text{Aluminium potassium sulfate.}$

$\text{Cr}_2(\text{SO}_4)_3, (\text{NH}_4)_2\text{SO}_4 = \text{Chromic ammonium sulfate.}$

$\text{Fe}_2(\text{SO}_4)_3, \text{Na}_2\text{SO}_4 = \text{Ferric sodium sulfate.}$

We may therefore express the composition of an alum, in a general way, by the formula :



in which R represents an atom of Cr, Mn, Fe, Gl, Al, Sc, Ga, or In ; and M an atom of Li, Na, K, Cs, Rb, or a group (NH_4) .

419. *To what substance is the name "alum" commonly applied?*

To the aluminium ammonium sulfate, crystallized with 24 molecules of water of crystallization : $\text{Al}_2(\text{SO}_4)_3, (\text{NH}_4)_2\text{SO}_4 + 24\text{Aq.}$ It is also known as "ammonia alum," and is the alumen, Br. The alumen, U. S., is the corresponding

potassium salt, formerly the "alum" of commerce, but now almost universally replaced by the ammonium salt.

420. *Wherein does Alumen exsiccatum, U. S., Br., differ from alumen?*

In having been subjected to heat, whereby the 24 molecules of water of crystallization are driven off. It is known commercially as "burnt alum."

421. *Give the tests for aluminium.*

1. With potash or soda, a white precipitate, soluble in excess of the precipitant.

2. With ammonium hydroxid, a white precipitate, almost insoluble in excess.

3. With disodic phosphate, a white precipitate, soluble in HCl , HNO_3 , or H_2SO_4 .

4. A solid compound of aluminium, heated on charcoal by the blowpipe flame in presence of cobalt nitrate, assumes a dark sky-blue color.

(For other elements of this group and the "periodic law," see Manual, pp. 162, 163.)

GROUP V.

LEAD..... Pb..... 207

422. *Give the symbol, atomic weight, and valence of lead.*

Symbol = Pb (Latin, Plumbum). Atomic weight = 207. It is bivalent in most of its compounds ; in some quadrivalent.

423. *What mineral is the most important ore of lead?*

A native sulfid, PbS , called galena. It frequently contains a considerable quantity of silver.

424. *Name some of the alloys into whose composition lead enters.*

Type metal, pewter, britannia metal, solder, shot. The last-named contains arsenic.

425. *Describe the physical properties of lead.*

A bluish-gray metal ; brilliant upon freshly cut surfaces ; very soft and pliable ; not readily malleable or ductile ; a poor conductor of electricity ; a better conductor of heat. Specific gravity = 11.5.

426. *Describe the actions of HCl , of HNO_3 , and of H_2SO_4 upon Pb.*

It is partly dissolved as $PbCl_2$ by strong HCl , particularly if heated. It is readily dissolved by HNO_3 as lead nitrate. Strong H_2SO_4 attacks Pb, solving a portion as lead sulfate, which is,

however, precipitated as a white powder when H_2O is added. Dilute H_2SO_4 produces a white coating of lead sulfate upon the metal. (See Q. 95.)

427. *What is the formula of lead monoxid, and under what other names is it known?*

PbO . Plumbi oxidum, U. S., Br.; litharge; massicot.

428. *How is it prepared, and what are its principal properties?*

It is prepared by heating lead in a current of air; direct union of the lead and oxygen takes place, forming a yellow powder known as massicot. When heated to redness this fuses, and, on cooling, forms coppery, crystalline scales, in which form it is known as litharge. Litharge should not be fused in an earthen crucible, as it combines with the silicic anhydrid to form a fusible lead silicate, and thus perforates the crucible. Litharge is sparingly soluble in water; the solution absorbs CO_2 from the air, and lead carbonate is precipitated. It is also soluble in solutions of the hydroxids of potassium, sodium, and calcium. It is a powerful base.

429. *For what purposes is PbO used in the arts?*

In the manufacture of glass, white lead, red lead, acetate of lead, for communicating a drying power to oils, in making the various plasters used in pharmacy. A solution of PbO in lime water is used as a hair dye; the lead, combining with sulfur from the hair, forms the black lead sulfid.

430. *Give the formula and other names of lead dioxid.*

PbO_2 . Puce-colored oxid of lead ; peroxid of lead ; plumbic anhydrid.

431. *Why is the name plumbic anhydrid given it?*

Because it is the anhydrid of a weak acid having the formula H_2PbO_3 . Although the acid has not been obtained, several of its salts are known, e.g., K_2PO_3 = potassium plumbate.

432. *How is red lead obtained, and under what other name is it known?*

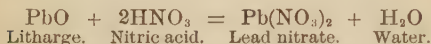
Litharge is further oxidized by roasting it in contact with air. It is known as red oxid of lead ; minium.

433. *What is the composition of red lead?*

It has not a constant composition, being a mixture, in various proportions, of two substances ; one the lead salt of plumbic acid (see Q. 431), or lead plumbate, PbPbO_3 , and the other lead monoxid, PbO . It usually has the composition $\text{PbPbO}_3 + \text{PbO}$.

434. *What compound of lead with a mineral acid is soluble in water, and how is it obtained?*

The nitrate, $\text{Pb}(\text{NO}_3)_2$. It is formed by dissolving the oxids or carbonate of lead in nitric acid :

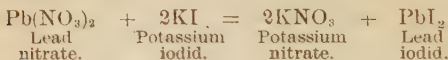


435. *What are the uses of lead nitrate?*

It is used in preparing the iodid. It enters into the composition of many disinfecting fluids. Ledoyen's disinfectant is a solution of this substance of the strength of a drachm to the fluid-ounce.

436. Give the formula of lead iodid, and its method of formation.

PbI_2 . It is obtained by adding solution of potassium iodid to solution of lead nitrate :



437. State the properties of lead iodid.

It forms a lemon-yellow powder, very sparingly soluble in cold water, more soluble in hot water, from which latter solution it separates in crystals. Its solution is colorless.

438. What yellow pigments are oxychlorids of lead?

Cassel, Paris, Verona, and Turner's yellows.

439. What is chrome yellow?

Neutral lead chromate.

440. Give the chemical and pharmaceutical names and formula of sugar of lead.

Neutral lead acetate; Plumbi acetas, U. S., Br.; $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 + 3\text{Aq}$. It is sometimes called salt of Saturn.

441. State the prominent properties of neutral lead acetate.

It crystallizes in large, colorless prisms. It is sweetish in taste, with a metallic after-taste. With water and with alcohol it forms solutions which are acid in reaction.

442. What reaction takes place between lead acetate and zinc sulfate?

The insoluble lead sulfate is precipitated and zinc acetate remains in the solution :



443. *Why are lead acetate and the vegetable astringents incompatible?*

Because the tannic acid of the astringent combines with the lead to produce an insoluble lead tannate.

444. *What pharmaceutical preparation contains a basic lead acetate, and how is it prepared?*

Liquor plumbi subacetatis, U. S., Br.; also known as Goulard's extract.

It is prepared by boiling a solution of lead acetate with litharge.

445. *What is white lead?*

A basic lead carbonate.

446. *What is meant by a basic or sub salt?*

A compound of the normal salt with a hydroxid, hydrate, or oxid of the metal. Thus, the normal lead carbonate being PbCO_3 , the basic carbonate constituting the greater part of white lead is $\text{Pb}(\text{CO}_3)_2, \text{PbH}_2\text{O}_2$.

447. *Give the analytical reactions of lead.*

1. With H_2S in acid solution, a black precipitate, insoluble in alkaline sulfids.

2. With ammonium sulfhydrate, a black precipitate, insoluble in excess.

3. With HCl , a white precipitate, if the solution be not too dilute. On heating, the precipitate is dissolved, and again deposited as a crystalline sediment on cooling.

4. With ammonium hydroxid, a white precipitate.

5. With H_2SO_4 , a white precipitate.

6. With potassium iodid, a yellow precipitate.

7. With potassium chromate, a yellow precipitate.

8. Iron and zinc separate the metal from solutions of its salts.

448. *Describe the prominent symptoms of acute lead poisoning.*

Metallic taste; dryness of the throat; thirst; severe colicky abdominal pains, referred particularly to the umbilical region, and relieved by pressure; pulse very feeble and slow; great prostration; constipation; urine scanty and red; violent cramps; paralysis of the lower extremities; convulsions; and tetanic spasms.

449. *What is the best antidote in acute lead poisoning?*

Magnesium sulfate, which brings about the formation of the insoluble lead sulfate, while the purgative action of the magnesia is also useful. It should be preceded by an emetic, or by the use of the stomach pump.

450. *What is the prognosis in acute lead poisoning?*

Favorable; about 80 per cent. recover.

451. *Give some of the prominent causes of chronic lead poisoning.*

The contamination of drinking water from lead pipes. Contamination of articles of food or drugs by contact with leaden vessels, or from being enclosed in tinfoil containing an excess of lead. Drinking beer, cider, etc., which has been drawn through leaden pipes or allowed to stand in pewter vessels. The ingestion or constant handling of lead or its compounds, as the acetate, nitrate, carbonate (white lead—painter's colic), Goulard's extract, etc. The use of hair dyes containing lead.

GROUP VI.

BISMUTH.....Bi.....207.5

452. *What are the symbol, atomic weight, and valence of Bi?*

Symbol = Bi. Atomic weight = 207.5. It is trivalent.

453. *What are its physical properties?*

A white, metallic substance, having peculiar reddish and greenish reflections; very brittle; fuses at 268° (514° F.); expands considerably on cooling; crystallizes in cubes; forms alloys with metals, some of which are fusible at very low temperatures.

454. *How is bismuth purified for use in pharmacy, and what is the object of the purification?*

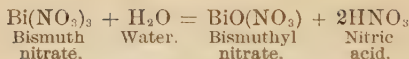
Commercial bismuth is always contaminated with arsenic, to separate which it is fused with about one fifth its weight of potassium nitrate.

455. *What is the action of nitric acid on bismuth?*

When bismuth is treated with nitric acid it is dissolved, brown fumes being given off. On cooling, white crystals of bismuth nitrate, $\text{Bi}(\text{NO}_3)_3$, form.

456. *What is the action of water upon bismuth nitrate?*

When the above solution is diluted with water, a white precipitate is formed. This is bismuthyl nitrate, or a nitrate of the group (BiO) , which behaves as an atom of an univalent metal:



This new substance is what is known as subnitrate of bismuth; Bismuthi subnitrates, U. S., Br. The process by which the salt is prepared pharmaceutically is more complicated; the object being the separation of arsenic.

457. *What are the so called oxysalts or subsalts of bismuth?*

They are salts of the group $(\text{BiO})'$, bismuthyl, which always behaves as an atom of an univalent metal; thus we have:

	Bismuth.	Bismuthyl.
Chlorid.....	BiCl_3	$(\text{BiO})\text{Cl}$.
Bromid.....	BiBr_3	$(\text{BiO})\text{Br}$.
Nitrate.....	$\text{Bi}(\text{NO}_3)_3$	$(\text{BiO})\text{NO}_3$.
Sulfate.....	$(\text{Bi})_2(\text{SO}_4)_3$	$(\text{BiO})_2\text{SO}_4$.
Carbonate ...	$(\text{Bi})_2(\text{CO}_3)_3$	$(\text{BiO})_2\text{CO}_3$.

458. *Describe the tests for bismuth.*

1. With H_2O , a white precipitate, except in presence of free HCl , HNO_3 , or H_2SO_4 .

2. With H_2S , a black precipitate, insoluble in alkaline sulfids.

3. With potassium, sodium, or ammonium hydroxid, a white precipitate, turning yellow when the liquid is boiled.

4. With potassium ferrocyanid, a yellowish precipitate.

5. With potassium ferricyanid, a yellowish precipitate.

6. With potassium iodid, a brown precipitate, soluble in excess.

GROUP VII. THE TIN GROUP.

TITANIUM.....	Ti.....	50.
ZIRCONIUM... ..	Zr.....	90.
TIN.....	Sn.....	117.7

TIN.

459. *What are the symbol, atomic weight, and valence of tin?*

Its symbol is Sn (Latin, Stannum). Its atomic weight is 118. It forms two series of compounds, in one of which it is bivalent, and in the other quadrivalent.

460. *For what purposes is tin used in the arts?*

1. For protecting iron from the action of air and moisture; the various "tin" articles used in the household are made of iron covered with a thin layer of tin. 2. For manufacturing tinfoil. 3. In the silvering of looking-glasses.

461. *What are meant by stannous and stannic compounds?*

Those compounds of tin in which that element is bivalent are called stannous: SnCl_2 = stannous chlorid; those in which it is quadrivalent are called stannic: SnCl_4 = stannic chlorid.

462. *How is stannous chlorid obtained, and what are its uses?*

By dissolving tin in hydrochloric acid with the aid of gentle heat. It is a strong reducing agent,

and is used in calico printing, and in the laboratory as a reagent for gold and mercury.

463. *Give the analytical characters of the stannous compounds.*

1. With ammonium hydroxid, a white precipitate, turning olive brown when the liquid is boiled.

2. With H_2S , a dark-brown precipitate, soluble in alkaline sulfids, in potassium hydroxid, and in hot H_2O .

3. With mercuric chlorid, a white precipitate, turning gray and black.

GROUP VIII. THE PLATINUM GROUP.

PALLADIUM	Pd .. .	105.7
PLATINUM.	Pt...	194.4

PLATINUM.

464. *How does platinum behave toward the mineral acids?*

It is indifferent toward any single mineral acid. Aqua regia dissolves it readily, with formation of platonic chlorid, PtCl_4 .

465. *To what uses is metallic platinum put?*

In making crucibles, dishes, and other vessels destined to bear a high heat without fusion, and in which acids may be heated. Large retorts made of this metal are used in the concentration of sulfuric acid.

466. *What precautions are to be had in using platinum vessels?*

Although not attacked by single acids, platinum vessels are injured by many substances. The metal is attacked by nitromuriatic acid, or any substance liberating chlorine. Platinum has a great tendency to alloy with other metals; therefore no metal or easily reducible oxid should be heated in contact with it. The alkalis and alkaline carbonates and, under certain conditions, the alkaline phosphates attack plati-

num. When these substances are to be heated, silver vessels should be used, care being taken, however, that the heat be not pushed beyond the fusing point of that metal. Platinum vessels should never be heated over an alcohol or coal fire, because when so heated the metal becomes blackened and brittle.

467. *What is the valence of platinum?*

It forms two series of compounds, in one of which it is bivalent, as in $\text{Pt}^{\text{II}}\text{Cl}_2$ = platinous chlorid; and in the other quadrivalent, as in $\text{Pt}^{\text{IV}}\text{Cl}_4$ = platinic chlorid.

468. *For what purpose is platinic chlorid used in chemistry?*

As a test for the presence of the compounds of potassium and ammonium, with which it forms insoluble, yellow, crystalline compounds; and as a test for certain alkaloids.

CLASS IV. BASYLOUS ELEMENTS.

469. *What are the characteristics of the basylous elements?*

Their oxids combine with water to form bases, never to form acids. They are capable of displacing the hydrogen of the oxyacids to form oxysalts.

470. *What elements are designated as metals?*

Those which are capable of displacing the hydrogen of oxyacids to form oxysalts. The amphoteric and basylous elements.

471. *Name the principal basylous elements.*

Lithium, sodium, potassium, silver, calcium, barium, magnesium, zinc, copper, mercury.

GROUP I. THE ALKALINE METALS.

LITHIUM.....	Li.....	7
SODIUM	Na	23
POTASSIUM.....	K.....	39
RUBIDIUM	Rb	85.3
CÆSIUM.....	Cs.....	133.
SILVER.....	Ag ...	108

NOTE.—Silver is not usually included in this group. It differs from the other members entirely in its physical properties and in being much less alkaline; but it resembles them in its valence and in the nature of its compounds.

472. *What term is used to designate the elements of this group?*

The alkaline metals.

473. *What are the common characters of the members of this group?*

Each forms a single chlorid and one or more oxids. Their hydroxids, $M'HO$, are strongly basic. They are univalent.

474. *To what elements was the name metalloid first applied, and why?*

To potassium and sodium. The word metalloid signifies "like a metal," and was given to these elements at the time of their discovery, because, although resembling the then known metals in some physical characters, they differ from them in others.

LITHIUM.

475. *What are the symbol and atomic weight of lithium?*

Its symbol is Li ; its atomic weight 7.

476. *What compounds of lithium are used in medicine?*

The bromid, $LiBr$ = Lithii bromidum, U. S.; and the carbonate, Li_2CO_3 = Lithii carbonas, U. S., Br.

SODIUM.

477. *What are the symbol and atomic weight of sodium?*

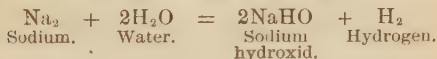
Its symbol is Na (Latin, Natrium). Its atomic weight is 23.

478. *What are the physical properties of elementary sodium?*

When pure, it is a brilliant, silver-white metal, crystallizing in cubes. As commonly met with, it is a bluish metal, coated with a brown film. It is lighter than water (sp. gr. 0.972). It fuses at 95.6 (204.1 F.), and may be distilled in an atmosphere of hydrogen. It is waxy in consistence at the ordinary temperature.

479. *What is the action of sodium on water?*

If a fragment of sodium be thrown upon water, it floats upon the surface, and gradually disappears, with a hissing noise, while hydrogen is given off and caustic soda is formed :



Sodium is similarly converted into NaHO by exposure to damp air ; hence it should be kept in some liquid free from oxygen, as benzine, or in closely sealed vessels.

480. *How is metallic sodium prepared?*

By heating a mixture of dry sodium carbonate, chalk, and charcoal to a white heat.

481. *What are the chemical name and formula of caustic soda?*

Sodium hydroxid—NaHO.

482. *Describe the prominent properties of NaHO.*

It is a hard, white, amorphous solid, very soluble in water, forming solutions which are intensely alkaline in reaction.

It is a powerful base, neutralizing acids with formation of sodium salts, and a strong corrosive.

On exposure to air it absorbs carbon dioxid and is converted into the carbonate. A strong solution of NaHO is called "Soda lye."

483. *What is common salt?*

Sodium chlorid, NaCl .

484. *Where does NaCl occur in nature?*

In the mineral world, deposited in the solid form, as "rock salt"; in soils; and in solution, in varying quantities, in all natural waters. In all animal tissues and fluids, and in less quantity in vegetable tissues.*

485. *What are the chief uses of NaCl in the arts?*

As a starting-point in the manufacture of most of the sodium compounds, hydrochloric acid, chlorin, bleaching powder; in the preservation of meats, fish, etc., and in glazing pottery.

486. *What are the chief impurities of commercial salt?*

Chlorids of calcium and magnesium. They communicate to the salt a somewhat bitter taste, and the property of absorbing moisture from the air.

487. *What functions does NaCl perform in the animal economy?*

It aids in the phenomena of osmosis throughout the body; aids in holding certain of the albuminoids in solution; and is the source from which the hydrochloric acid of the gastric juice is probably derived.

488. *How is it eliminated?*

By all the excretions, principally in the urine. (See Manual, p. 178.)

489. *What data are required to calculate the quantity of bromin in 100 parts of sodium bromid?*

1st. Its formula— NaBr . 2d. The atomic weight of sodium—23, and that of bromin—80; the sum being of course the molecular weight of $\text{NaBr} = 103$. 3d. Whether or no the substance in the condition used contains water of crystallization or not.

NOTE.—This last point must not be lost sight of. NaBr contains no water of crystallization, and if we weigh out 103 parts we will have 80 parts Br; but suppose it contained 1 molecule of water of crystallization, its formula would then be $\text{NaBr} + \text{Aq.}$ and to get 80 parts Br we would have to take $23 + 80 + 2 + 16 = 121$ parts.

490. *Calculate how much iodin there is in 100 parts of sodium iodid.*

Its formula is NaI , and it contains no water of crystallization. Its molecular weight is, therefore, $23 + 127 = 150$, or 150 parts NaI contain 127 parts I. Therefore :

$$150 : 100 :: 127 : x \qquad x = 84.66$$

491. *Give the formula and synonyms of sodium nitrate.*

NaNO_3 . Chili saltpetre; cubic nitre; Sodæ nitras, U. S., Br.

492. *Give the formulæ and names of the sulfates of sodium.*

Monosodic sulfate, NaHSO_4 , also known as acid sodium sulfate or bisulfate of sodium. Disodic sulfate, Na_2SO_4 , also known as neutral sodium sulfate, Glauber's salt; Sodii sulphas, U. S.; Sodæ sulphas, Br.

493. *Where does disodic sulphate occur in the animal economy?*

In all tissues and fluids, except the milk, bile, and gastric juice.

494. *Give the formula and names of the phosphates of sodium.*

Monosodic phosphate, NaH_2PO_4 = acid sodium phosphate. Disodic phosphate, Na_2HPO_4 = phosphate of soda; Sodii phosphas, U. S.; Sodæ phosphas, Br. Trisodic phosphate, Na_3PO_4 = basic phosphate of soda.

The first named crystallizes with 1Aq, the last two with 12Aq.

495. *In what portions of the animal body do the phosphates of sodium occur?*

In all parts.

496. *In what animal fluids does the trisodic phosphate predominate, and what function does it perform?*

In the blood; in greater proportion the more strictly animal the diet. The alkalinity of the blood is largely due to this salt.

497. *In what relative proportions do the phosphates of sodium and potassium occur in the body?*

They accompany each other in all parts; the sodium salt being much more abundant in all situations except in the blood corpuscles and in the muscular tissue, in which the potassium compounds predominate.

498. *To what is the acid reaction of human urine due?*

To the presence of monosodic and monopotassic phosphates.

499. *How are phosphates produced in the animal body?*

By the processes of disassimilation of nerve-tissue, which contains phosphorized organic substances, the oxidation of whose phosphorus is attended by the formation of phosphates.

500. *What are the alkaline phosphates of the urine?*

The phosphates of sodium and potassium. They are so called because they are the phosphates of the "alkaline metals," although they are acid salts. (See Laboratory Guide, pp. 53-55.)

501. *What is borax?*

Sodium pyroborate, or tetraborate, $\text{Na}_2\text{B}_4\text{O}_7 + 10\text{Aq.}$

502. *What sodium salt exists in Liq. Sodæ Chlorinatæ, U. S., Br.?*

Sodium hypochlorite, NaClO .

503. *Give the names and formulæ of the carbonates of sodium.*

Monosodic carbonate, NaHCO_3 , also called bicarbonate of soda, cooking soda, acid carbonate of soda, Sodii bicarbonas, U. S., and Sodæ bicarbonas, Br. Disodic carbonate, NaCO_3 , also called carbonate of soda, washing soda, sal-soda, soda, soda crystals, Sodii carbonas, U. S., and Sodæ carbonas, Br.

The former crystallizes without Aq, the latter with 10Aq.

504. *What is the reaction of solutions of these carbonates?*

It is distinctly alkaline; that of the carbonate

being more markedly so than that of the bicarbonate.

505. *Of what importance is the disodic carbonate in the arts?*

It is manufactured in large quantities, and is used in many important industrial operations, e.g., glass and soap manufacture, calico printing, and as a starting-point in obtaining the various compounds of sodium. It is used in the laundry to soften hard water.

506. *How are the carbonates of potassium and sodium formed in the economy, and what is their function?*

By the oxidation of sodium and potassium salts of other organic acids existing in plants. Their main function is the preservation of alkaline reaction of the circulating fluids in the herbivora, and to a greater or less degree in man. The administration of vegetable acids communicates an alkaline reaction to the urine by reason of their oxidation in the body, with formation of carbonates of sodium and potassium.

507. *To what substance does the name sal aeratus properly apply, and to what is it commonly applied?*

It was originally used to designate potassium bicarbonate, but at present the article universally sold and used under the name "sal aeratus" is monosodic carbonate.

508. *For what purpose and how is monosodic carbonate used in baking?*

As a source of carbon dioxid gas, whose liberation "raises" the bread. It is used either alone or combined with some acid salt.

509. *Why should it not be used alone?*

Because under the influence of heat it is decomposed according to the equation:



and the product of the baking consequently contains the strongly alkaline disodic carbonate.

510. *What chemicals are used in the manufacture of baking powders?*

Monosodic carbonate (bicarbonate); monopotassic tartrate (cream of tartar); alum (ammonium aluminium sulfate); monosodic phosphate; tartaric acid; ammonium carbonate; starch. (See Manual, pp. 188, 189.)

POTASSIUM.

511. *What are the symbol and atomic weight of potassium?*

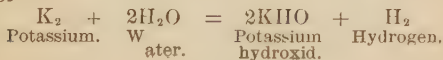
Its symbol is K (Latin, Kalium); its atomic weight is 39.

512. *What are the physical properties of potassium?*

A silver-white, metallic body; soft at ordinary temperatures. melts at $62^{\circ}.5$ ($144^{\circ}.5$ F.), and at red heat boils, with formation of green vapors. It is lighter than water.

513. *What is the action of potassium on water and air?*

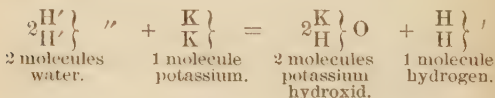
Potassium decomposes water with great energy:



The action is so violent that flame and a slight explosion are produced. K has also a great tendency to unite with oxygen, and, if this be perfectly dry, potassium oxid, K_2O , is formed. When potassium is exposed to air, its surface is rapidly coated with a yellowish-white layer of KHO . In order to preserve the metal it must be kept under some substance containing no oxygen, as benzine.

514. *What is the constitution of potassium hydroxid?*

It is a molecule of water in which one atom of hydrogen has been replaced by one atom of potassium :



Or, in other words, it is a molecule composed of one atom of bivalent oxygen, united with one of each of the univalent atoms, hydrogen and potassium.

515. *Under what other names is potassium hydroxid known?*

Potash ; Potassa, U. S. ; Potassa caustica, Br. ; Potassa fusa ; Potassa alba.

516. *What are the physical properties of KHO ?*

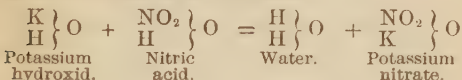
It is a hard, white solid (usually in the shape of sticks, about one-quarter inch in diameter and six inches long), opaque, brittle ; melts at a dull red heat ; very soluble in water, less so in alcohol. Has a strong, soapy taste, even in dilute solution.

517. *Why should KHO and its solutions be protected from air?*

Because they rapidly absorb carbonic anhydrid, forming potassium carbonate, and in course of time the hydroxid will be entirely replaced by the carbonate.

518. *State some of the chemical properties of KHO.*

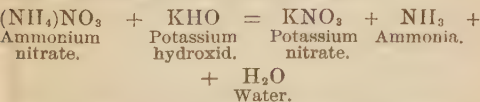
It is a powerful base, entering readily into reaction with acids to form salts :



It has a strong alkaline reaction, and is a powerful caustic, dissolving most animal tissues. In concentrated solution it attacks glass. Its solution dissolves sulfur, phosphorus, chlorin, bromin, and iodin, forming with these elements compounds soluble in water.

519. *What is the action of KHO on ammonium salts?*

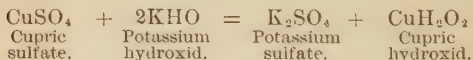
Being a stronger base than ammonium, it decomposes the ammoniacal salt, with formation of a potassium salt, water, and ammonia :



520. *What is the action of solution of KHO on solutions of most metallic salts?*

It decomposes the salt, with formation of the

corresponding potassium salt and a metallic hydroxid :



Some of the hydroxids being of characteristic color, and insoluble in water, solution KHO is used as a test reagent.

521. *What is the composition of potassium chlorid, and where does it exist in nature?*

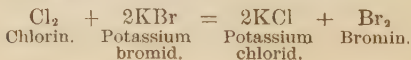
KCl. It is very widely distributed in mineral, vegetable, and animal nature. As a double chlorid of potassium and magnesium it constitutes a mineral, called *carrollite*, which is the chief mineral source of the potassium compounds. It is found in all animal tissues and fluids, accompanying the corresponding sodium compound, but in much less quantity. In the red blood corpuscles and in muscular tissue the K salt predominates over the Na.

522. *What are the composition and physical properties of potassium bromid?*

KBr. It forms milk-white cubes containing no water of crystallization; unaltered by exposure to air; odorless; having a peculiar salty taste. Soluble in $1\frac{1}{2}$ parts of cold water, and easily soluble in alcohol.

523. *What is the action of chlorin upon KBr? Write equation.*

It decomposes it, with formation of the chlorid and liberation of bromin :



524. *What reaction takes place between solutions of KBr and those of mercurous, lead, or silver salts?*

The bromin unites with the mercury, lead, or silver to form corresponding bromids, which are insoluble. With solution of mercuric chlorid (corrosive sublimate) it gives no precipitate. If it do, the bromid is contaminated with potassium iodid.

525. *What are the composition and physical properties of potassium iodid?*

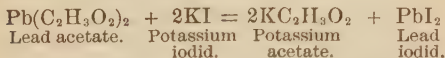
KI. It forms milk-white cubes without water of crystallization; odorless; having a sharp, bitterish, saline taste; unaltered by exposure to air (when it becomes damp it is impure). Very soluble in water, less so in alcohol; the solutions being clear, colorless, and neutral.

526. *Why is KI incompatible with the insoluble mercurials?*

Because it renders them soluble to a greater or less extent, and consequently much more active.

527. *What takes place when KI and metallic salts are combined?*

The formation of the potassium salt of the acid and iodid of the other metal:



This reaction is important in the cases of lead, bismuth, copper, and silver.

528. *What is the action of chlorin, bromin, or fuming nitric acid upon KI?*

The salt is decomposed, with liberation of free iodin.

529. *What are the formula and common names of potassium nitrate?*

KNO_3 . Potassii nitras, U. S. ; Potassæ nitras, Br. ; saltpetre ; nitre.

530. *What is the origin of KNO_3 ?*

It has its origin in the oxidation of animal or vegetable substances rich in nitrogen, in the presence of potassium. It is thus formed both naturally and artificially.

531. *What are the chief uses of KNO_3 ?*

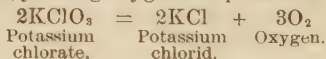
In the manufacture of nitric and sulfuric acids, and of gunpowder ; in packing beef and pork. In the laboratory it is used as an oxidizing agent.

532. *What are the formula and physical properties of potassium chlorate?*

$KClO_3$. Occurs in transparent, colorless plates, without water of crystallization ; permanent in air ; odorless ; has a cool, salty taste ; soluble in 30 parts of cold water ; sparingly soluble in alcohol. Its aqueous solution is colorless, and neutral in reaction.

533. *What decomposition does $KClO_3$ undergo when heated?*

It first fuses, and at higher temperatures is decomposed, yielding oxygen and potassium chlorid:



This is the reaction generally utilized for the production of oxygen.

534. *What precaution is to be had in dispensing $KClO_3$?*

It should never be combined with any organic or easily oxidizable substance, or with any strong

acid or acid sulfate. With these substances KClO_3 is readily decomposed, forming substances which are violently explosive.

535. *What is Javelle Water?*

A solution of potassium hypochlorite, KClO ; a compound which is only known in solution, and is formed by passing chlorine through a cold solution of potassium carbonate. It is a clear, colorless liquid, having an odor of chlorine, and a bleaching action upon vegetable colors. It is used in removing stains from fabrics.

536. *Give the names and formulæ of the sulfates of potassium.*

Monopotassic sulfate, KHSO_4 , hydropotassic sulfate, acid sulfate, bisulfate of potassium. Dipotassic sulfate, K_2SO_4 , sulfate of potassium, Potassii sulphas, U. S.; Potassæ sulphas, Br.

537. *Give the names and formulæ of the carbonates of potassium.*

Monopotassic carbonate, KHCO_3 = hydropotassic carbonate, bicarbonate, Potassii bicarbonas, U. S.; Potassæ bicarbonas, Br.; sal aeratus. Dipotassic carbonate, K_2CO_3 = salt of tartar, pearl-ash, potash, Potassii carbonas, U. S.; Potassæ carbonas, Br.

537a. *Describe the analytical characters of lithium, sodium, and potassium.*

They are most readily detected by the colors which they communicate to the blue Bunsen flame: lithium, a bright red; sodium, yellow; potassium, violet. The latter is only visible in the presence of Na when the flame is observed through a blue glass, or a glass vessel filled with dilute indigo solution.

Sodium salts form a white, *crystalline* precipitate with potassium pyroantimonate solution.

Potassium chlorid gives a yellow, crystalline precipitate with platinic chlorid solution. The liquid must not contain ammoniacal salts.

538. *What action have the hydroxids of sodium and potassium upon the economy?*

They act as powerful corrosives. The symptoms are practically the same as those observed in corrosion by the mineral acids (see Q. 147), except in corrosion by the alkalies a soapy taste, followed almost immediately by a burning sensation, is experienced in place of an acid taste. The reaction of the vomited matters, or of the vessel from which the corrosive was taken, is the most certain means of diagnosis. The method of death and post-mortem appearances, apart from reaction, are the same as in corrosion by the mineral acids. (See Q. 148, 151.)

539. *What is the action of the carbonates of sodium and potassium on the animal economy?*

The same as that of the hydroxids, but much less intense in equal dose. In the case of the potassium salt, the true poisonous action (see Q. 541) is usually the more important.

540. *What treatment should be adopted in corrosion by potash or soda?*

The alkali should be neutralized as speedily as possible by the administration of a weak acid, acetic acid in the form of vinegar being the most available. Oils or milk are of service, more as emollients than as true antidotes. The stomach pump is *not* to be used.

541. *How do the salts of potassium differ from those of sodium in their action on the animal economy?*

In any reasonable quantity the sodium compounds are inert beyond such action as they may owe to the acid or to their reaction. The potassium salts are possessed of truly poisonous qualities; they cause dyspnoea, diminution of the blood pressure, convulsions, and death from arrest of the heart's action.

SILVER.

542. *Give the symbol and atomic weight of silver.*

Its symbol is Ag (Latin, Argentum); its atomic weight 108.

543. *State the principal physical properties of Ag.*

A white metal, capable of a high polish; very malleable and ductile; the best known conductor of heat and electricity; harder than Au, softer than Cu; sp. gr. 10.4–10.5.

544. *Mention some of the chemical properties of silver.*

It is not oxidized in dry or moist air at any temperature. If the air contain traces of hydrogen sulfid the surface of the metal becomes tarnished by the formation of the black silver sulfid. It is attacked at ordinary temperatures by Cl, Br, I, and S. It is not attacked even at high temperatures by the caustic or carbonated alkalies. Silver acts readily upon nitric acid, with formation of silver nitrate.

545. *What is coin silver?*

An alloy of silver and copper.

546. *What is lunar caustic ?*

Silver nitrate, AgNO_3 = Argenti nitras fusa, U. S.; Lapis infernalis. It is prepared by dissolving silver in nitric acid, and heating the crystalline residue until it fuses, when it is cast into moulds.

547. *What action has nitrate of silver upon animal tissues ?*

In contact with animal matter silver nitrate is rapidly decomposed, metallic silver being deposited and producing the characteristic black stain, while free nitric acid is liberated. It is to the liberation of this substance that lunar caustic owes its action as an escharotic.

548. *Give the analytical characters of the silver salts.*

1. With HCl a white precipitate, insoluble in HNO_3 , soluble in ammonium hydroxid.

2. With NaHO , or KHO , a brown precipitate, insoluble in excess.

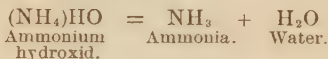
3. With H_2S a black precipitate, insoluble in alkaline sulfids.

AMMONIUM.

549. *What is the ammonium theory ?*

The ammoniacal compounds, such as sal-ammoniac, are not compounds of ammonia gas, but of a group of atoms (NH_4) called *ammonium*. This group behaves like an atom of an univalent metal, such as potassium. As potassium chlorid has the formula KCl , so ammonium chlorid has the formula $(\text{NH}_4)\text{Cl}$. Liquor ammoniæ is not a simple solution of ammonia gas in water; it con-

tains a true ammonium hydroxid (NH_4HO), corresponding in all respects to the hydroxids of potassium and sodium, KHO and NaHO , except that upon being heated it is decomposed into ammonia gas and water:



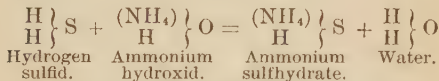
Ammonium has not yet been obtained in a free state with certainty, but an amalgam may be readily obtained, corresponding to the amalgams of sodium and potassium. (See Manual, p. 194.)

550. *What is the present source of the ammoniacal compounds?*

The "ammoniacal liquor" obtained in manufacturing illuminating gas. This is distilled, and the distillate passed into HCl or H_2SO_4 , when ammonium chlorid or sulfate is formed.

551. *How is ammonium sulfhydrate prepared?*

By passing H_2S through a solution of NH_4HO :



552. *What are the properties and uses of the solution thus obtained?*

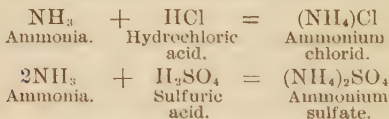
When freshly prepared, it is a colorless liquid, having the odor of ammonia, as well as that of hydrogen sulfid; when old it assumes a yellow color. It is a valuable reagent in analysis.

553. *Give the names and formula of ammonium chlorid.*

Ammonium chlorid, muriate of ammonia, sal-ammoniac, Ammonii chloridum, U. S., Br. $(\text{NH}_4)\text{Cl}$.

554. *What reaction takes place when ammonia gas comes in contact with an acid?*

The two unite to produce an ammonium salt, without liberation of hydrogen, thus :



555. *How are the ammoniacal compounds affected by heat?*

They are completely volatilized, unless they are salts of a fixed acid.

556. *Give the analytical characters of the ammonium salts.*

1. When heated with KHO they give off NH_3 , which may be recognized by its odor, by its turning moist red litmus paper blue, and by the formation of a white cloud when a glass rod, moistened with HCl solution, is held over the vessel.

2. With platinic chlorid, a yellow, crystalline precipitate, converted into a gray, spongy mass when heated.

557. *Wherein does ammonium hydroxid differ from the hydroxids of potassium and sodium in its action on the economy?*

In the severe dyspnœa which it produces,

Owing to the readiness with which NH_3 is given off, the corrosive action of NH_4HO is usually insignificant compared to the action of the NH_3 upon the air passages.

GROUP III. METALS OF THE ALKALINE EARTHS.

CALCIUM ..	Ca	40
STRONTIUM ..	Sr	87.5
BARIUM.....	Ba.....	137

558. *State the characteristics of elements of this group.*

They are bivalent ; they form two oxids, having the composition MO and MO_2 ; their sulfates and carbonates are insoluble or very sparingly soluble ; their hydroxids are known as the alkaline earths.

CALCIUM.

559. *How does calcium exist in nature?*

In its compounds it is one of the most abundant of the elements. Its carbonate exists as chalk, marble, limestone, etc. ; its sulfate as gypsum and alabaster, and several other compounds exist in various minerals. Its compounds also occur in animal and vegetable tissues.

560. *Give the formula and common names of calcium monoxid.*

CaO . Calx, U. S., Br. ; Calx viva ; quicklime.

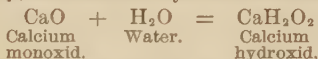
561. *State the method of its preparation, and its properties.*

It is obtained by heating limestone, which is a

native calcium carbonate. It forms white, amorphous masses. It is odorless; has a caustic, alkaline taste, and alkaline reaction. When exposed to the air, it absorbs water and carbonic anhydrid, falling to a powder composed of a mixture of calcium carbonate and hydroxid; it is then said to be air-slaked.

562. *What takes place when calcium monoxid is treated with water?*

When H_2O is thrown upon CaO , a crackling sound is heard, much heat is liberated, the lime swells up, and calcium hydroxid is formed:



This is known as slaked lime, and is a light, white powder, odorless, having an alkaline taste and reaction. It is sparingly soluble in cold H_2O , and less soluble in hot H_2O . It absorbs carbonic anhydrid readily from the air, forming calcium carbonate.

563. *What are lime water and milk of lime?*

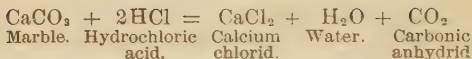
The former is a solution of calcium hydroxid in water; the latter is such a solution holding in suspension a great excess of calcium hydroxid.

564. *Give the formula and common names of calcium chlorid.*

$CaCl_2$. Calcii chloridum, U. S., Br.; muriate of lime.

565. *How is it obtained, and what are its prominent properties?*

It is formed when hydrochloric acid acts upon a compound of calcium which it is capable of decomposing:



It is odorless, and has a sharp, salty taste. When fused and allowed to cool, it forms a rough, amorphous mass, which absorbs water with great energy and is used as a drying agent.

566. *What is the difference between calcium chlorid and chloride of lime?*

The former is a definite compound, CaCl_2 , while the latter is a mixture containing calcium hypochlorite, $\text{Ca}(\text{ClO})_2$.

567. *Under what other name is chloride of lime known, and what are its properties and uses?*

Bleaching powder. The hypochlorite is very readily decomposed by acids, with evolution of chlorin, which then acts as a powerful bleaching and disinfecting agent. When exposed to the air, it is decomposed by the carbonic anhydrid contained therein.

568. *What are gypsum, terra alba, and plaster of Paris?*

Gypsum is a native calcium sulfate, containing two molecules of water of crystallization, $\text{CaSO}_4 + 2\text{Aq}$. Terra alba is gypsum ground to a fine powder. When gypsum is heated the Aq is driven off. The remaining substance, CaSO_4 , is plaster of Paris, and has the power of taking up water, when mixed with it, to form a hard, solid mass.

569. *What objection is there to the use of plaster in the ordinary way on walls of hospitals?*

It forms a coating which is porous and uneven. In these pores and upon the projections various

deleterious organic substances collect to such an extent that, by scratching the surface of plaster in a hospital, a powder has been obtained containing as much as 46 per cent. of organic matter.

570. *How may this defect be remedied?*

By adding to the ordinary mixture of plaster and water, used in plastering, a certain proportion of alum and gelatin, or of soluble glass. This mixture, on "setting," forms a hard surface, which is then polished.

571. *Give the names and formulæ of the phosphates of calcium.*

Monocalcic phosphate, $\text{Ca}(\text{H}_2\text{PO}_4)_2$ = acid calcium phosphate, superphosphate of lime. Dicalcic phosphate, $\text{Ca}_2(\text{HPO}_4)_2$. Tricalcic phosphate, $\text{Ca}_3(\text{PO}_4)_2$ = tribasic or neutral phosphate of lime, bone phosphate, Calcii phosphas præcipitatus, U. S.; Calcii phosphas, Br.

572. *How does $(\text{PO}_4)_2\text{Ca}_3$ exist in the animal economy?*

It is the most abundant mineral ingredient of the body, and is found in every tissue and fluid, most abundantly in the bones and teeth. In the fluids it exists in small proportion, except in the milk, where it is found in comparatively large quantity (about $2\frac{1}{2}$ parts per 1,000). In the bones it is in combination (along with other mineral substances) with an organic substance, and upon the relative proportions of these two the rigidity and tenacity of the bone depend.

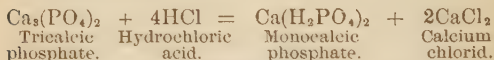
573. *How is "bone black" prepared, and what is its composition?*

It is obtained by subjecting bones to a red heat without access of air. It is composed of carbon,

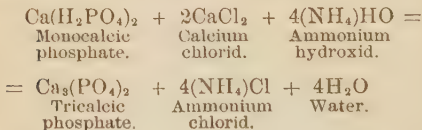
tricalcic phosphate, and small quantities of other salts (calcic carbonate, trimagnesian phosphate, and calcic fluorid). By treating it with dilute hydrochloric acid the mineral substances are removed, and "purified animal charcoal" remains.

574. *How may pure tricalcic phosphate be obtained?*

The impure salt, bone-ash, is acted on by HCl, when the soluble monocalcic phosphate and calcium chlorid are formed :



Ammonium hydroxid is then added to the solution, when pure tricalcic phosphate (Calcis phosphas præcipitata, U. S. P.) is precipitated, and ammonium chlorid remains in solution :



575. *What is "superphosphate of lime"?*

An impure monocalcic phosphate, obtained by acting on bone-ash with sulfuric acid. It is used as a manure.

576. *In what parts of the body does monocalcic phosphate exist?*

In brain tissue and in the acid fluids; in the urine. This salt and the corresponding magne-

sium compound are known as "earthy phosphates."

577. *What mineral salts are sometimes deposited from the urine in calculi?*

The earthy phosphates, *i.e.*, tricalcic and trimagnesian phosphates; and ammonio-magnesian phosphate.

578. *What is the reaction of the urine during formation of a phosphatic calculus?*

It is alkaline, or at least markedly less acid than normal.

(See Manual, pp. 200, 201.)

579. *In what forms does calcium carbonate occur in nature?*

Exceedingly abundant as marble, limestone, chalk, and calc spar, and in almost all natural waters and soils, in juices of plants, the shells of mollusks and crustacea, bones, teeth, and animal fluids, coral and pearls.

580. *How is it prepared artificially, and by what name is it then known?*

By adding sodic carbonate to solution of calcium chlorid. Calcis carbonas præcipitata, U. S., Br.; precipitated chalk.

581. *What is prepared chalk?*

It is native chalk ground to a fine powder and separated from all coarser particles by elutriation = Creta præparata, U. S., Br.

582. *State the properties of calcium carbonate.*

An amorphous white powder, odorless, tasteless, very sparingly soluble in pure water, much more soluble in water containing carbon dioxid. When strongly heated, CO_2 is driven off and quicklime remains.

583. *What is the appearance of a mulberry calculus, and of what is it composed?*

It is hard, dark brown or gray, sometimes smooth, usually nodulated or covered with short tubercles, soluble in HCl, and, when heated, blackens and finally leaves a white, alkaline residue. It consists mainly of calcium oxalate, CaC_2O_4 .

584. *Describe the analytical reactions of the Ca compounds.*

1. With alkaline carbonates, a white precipitate, soluble in HCl.

2. With ammonium oxalate, a white precipitate, soluble in HCl.

3. With H_2SO_4 , a white precipitate, either immediately or on addition of two volumes of alcohol.

BARIUM.

585. *What compound of barium is used in analysis, and for what purpose?*

Barium chlorid, BaCl_2 , is used as a test for the presence of sulfuric acid or of a soluble sulfate; a white precipitate of barium sulfate, *insoluble in nitric acid*, is formed.

586. *What antidotes should be given in poisoning by the soluble barium compounds?*

Magnesium or sodium sulfate.

GROUP IV. MAGNESIUM GROUP.

MAGNESIUM.....	Mg	24
ZINC.	Zn.....	65
CADMIUM.....	Cd.....	112

587. *Describe the common characters of the elements of this group.*

Each forms a single oxid and a corresponding basic hydroxid. In their salts they are always bivalent.

MAGNESIUM.

588. *Describe the properties of Mg.*

It is a silver-white metal, hard, light, and ductile. It burns in air with a brilliant white light and with formation of MgO . It dissolves in dilute acids.

589 *Give the formula and common names of magnesium oxid.*

MgO . Magnesia, U. S., Br.; Magnesia lævis; Magnesia usta; calcined magnesia.

590. *State its properties.*

It is a very light, amorphous, white powder; infusible: very sparingly soluble in water. With HNO_3 , H_2SO_4 , HCl it forms the corresponding salt. (Effervescence denotes contamination with magnesium carbonate.)

591. *What is "milk of magnesia"?*

Magnesium hydroxid held in suspension in water (1 part MgO to 10-20 parts H_2O).

592. *Under what other names is magnesium sulfate known, and what is its formula?*

Magnesii sulphas, U. S.; Magnesiae sulphas, Br.; sulfate of magnesia; Epsom salts. $MgSO_4$.

593. *Give the characters of $MgSO_4$.*

It forms colorless, transparent crystals, containing 7 molecules of water of crystallization. Easily soluble in water, the solution being neutral. Insoluble in alcohol.

594. *What is triple phosphate, how is it formed, and of what pathological interest is it?*

It is ammonio-magnesian phosphate, $(NH_4)-MgPO_4 + 6Aq$. It is produced whenever a magnesium salt is brought in contact with an alkaline phosphate and an ammonium salt, the reaction being alkaline. In the urine, alkaline phosphates and magnesium salts are always present; hence when ammonia is produced by decomposition of urea, the conditions for the deposition of this compound are fulfilled. Frequently it is deposited in the form of single, brilliant, tabular crystals. In some cases it is slowly deposited, when it forms a "fusible calculus."

595. *How may a magnesium compound be detected in the presence of compounds of barium and calcium?*

The barium and calcium compounds must be first separated thus: Add to the solution ammonium chlorid and hydroxid, then ammonium carbonate; the barium and calcium compounds are precipitated and removed by filtration. To the

clear filtrate add solution of sodium phosphate; if magnesium be present, a crystalline precipitate of ammonio-magnesian phosphate is formed.

ZINC.

596. *For what purposes is zinc used?*

In the manufacture of brass, which is an alloy of copper and zinc, and of German silver. "Sheet zinc" is zinc rolled out into thin plates; galvanized iron is sheet iron (or iron wire, etc.) covered with a thin coating of zinc. Galvanized iron and zinc should not be used in vessels intended to contain articles of food, as fatty matter, milk, and even water become rapidly charged with soluble zinc compounds when kept in vessels made of these substances. Zinc is largely used in galvanic batteries, and in the laboratory to obtain hydrogen.

597. *How is commercial zinc nearly always contaminated?*

With arsenic, iron, lead, and phosphorus.

598. *How is zinc oxid obtained?*

1. By subjecting zinc carbonate to heat. The Zinci oxidum, U. S., Br., is thus prepared from the officinal zinc carbonate, which is a mixture of the true carbonate, ZnCO_3 , and the hydroxid, ZnH_2O_2 . 2. By burning metallic zinc in a current of air. This process is used on a large scale in the arts in the manufacture of "zinc white," which is used as a pigment.

599. *State the differences between samples of zinc oxid prepared by the above processes.*

That prepared by 1 is of a pale-yellow color when cold, and yellow when hot, while that pre-

pared by 2 is pure white and forms light, flocculent masses, whence it was formerly known as "Lana philosophica." That prepared by 1 is liable to contain an excess of carbonate.

600. *State how zinc chlorid is obtained, and its properties.*

By dissolving Zn in HCl and evaporating the solution. It is a white solid, crystallizes with difficulty, and is very soluble in water. It combines readily with albuminoid substances. It is used medicinally as an escharotic, and for the preservation of anatomical material.

601. *Describe the action of zinc upon sulfuric acid.*

If both substances be pure, there is no action; but if the acid be diluted with water, the zinc is dissolved, zinc sulfate and hydrogen resulting.

Pure Zn acts much less readily on H_2SO_4 than when it is contaminated with other metals. In galvanic batteries, it is desirable that the action between zinc and acid should only take place while the circuit is closed; this end is attained by "amalgamating" the zincs, *i.e.*, coating them with an amalgam of zinc and mercury. Plates so protected behave towards H_2SO_4 like pure zinc.

602. *Why is zinc sulfate incompatible with vegetable astringents?*

Because they contain tannic acid, with which the zinc salt forms an insoluble compound.

603. *Under what other names is zinc sulfate known, and what is its formula?*

White vitriol, Zinci sulphas, U. S., Br. As usually met with its composition is $\text{ZnSO}_4 +$

7Aq; although it also crystallizes with 1, 2, 4, 5, 6Aq.

604. *Describe the analytical reactions of the Zn salts.*

1. With ammonium sulfhydrate, a white precipitate.

2. With hydroxids of K, Na, or (NH_4) , white precipitates, soluble in excess.

3. With potassium ferrocyanid, a white precipitate.

605. *What preparations of zinc are liable to give rise to cases of poisoning?*

A strong solution of the chlorid with excess of acid used by tinsmiths. A disinfecting agent, known as Sir Wm. Burnett's solution, composed of 230 grains ZnCl_2 to the ounce of water. Zinc sulfate taken by mistake.

606. *What should be the treatment?*

If the poison have not produced emesis, it should be induced. Milk, white of egg, or, better, some substance containing tannic acid, such as tea, infusion of bark, etc., should be given.

GROUP VI. COPPER GROUP.

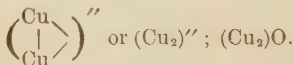
COPPER.....	Cu.....	63.5
MERCURY.....	Hg.....	200.

607. *What is the valence of elements of this group?*

They are bivalent.

608. *How many classes of salts do these elements form, and wherein do they differ?*

Two. In one class a single atom of the element acts in its bivalent capacity, Cu'' , thus: $\text{Cu}''\text{SO}_4$; in the other class two atoms of the element, linked together, form a group which behaves like a single bivalent atom, thus:



609. *Explain the nomenclature of these compounds.*

Those compounds containing the single atom are designated by the termination *ic*, while those containing the double atom $(\text{Cu}_2)''$ or $(\text{Hg}_2)''$ are designated by the termination *ous*. Thus CuO is known as cupric oxid, and $(\text{Cu}_2)\text{O}$ as cuprous oxid; HgCl_2 as mercuric chlorid, and $(\text{Hg}_2)\text{Cl}_2$ as mercurous chlorid. The termination *ous* applies to that compound containing the greater proportion of metal, while the termination *ic*

designates that containing the greater proportion of the other element or group of elements ; thus we have :

Mercurous chlorid,	Hg : Cl :: 2 : 2
Mercuric “	Hg : Cl :: 1 : 2
Cuprous oxid,	Cu : O :: 2 : 1
Cupric “	Cu : O :: 1 : 1

COPPER.

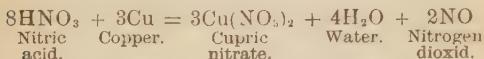
610. *How may pure copper be obtained?*

By decomposing cupric sulfate by means of the battery (electrotype). By heating cupric oxid in a current of hydrogen.

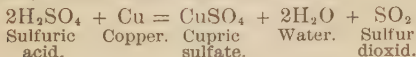
611. *What action takes place between copper and the mineral acids?*

Copper decomposes hydrochloric acid with difficulty, except when the metal is finely divided.

Nitric acid is energetically acted on, nitrogen dioxid being given off, and cupric nitrate remaining in solution :



Warm sulfuric acid, with copper, forms cupric sulfate, while sulfur dioxid is evolved :



612. *What action takes place between copper and certain organic acids?*

Many weak acids are decomposed, with forma-

tion of salts of copper. When this metal is exposed to damp air it becomes coated with a green layer of the carbonate. Acetic acid (vinegar), in contact with copper, forms the acetate. The fatty acids also combine with the metal.

613. *Give the names and formulæ of the oxids of copper.*

Cuprous oxid, Cu_2O , also known as red, or sub-oxid of copper; cupric oxid, CuO , also known as black, or protoxid of copper.

614. *What decomposition takes place when cupric oxid and an organic substance are heated together, and how is this utilized?*

The oxid gives up its oxygen, which, uniting with the carbon and hydrogen of the organic substance, forms carbonic anhydrid and water, while metallic copper remains. This reaction affords us one of the best means of analytically determining the quantity of carbon and hydrogen entering into the composition of an organic compound.

615. *What is blue vitriol?*

Cupric sulfate, CuSO_4 . Cupri sulphas, U. S., Br.; blue stone.

616. *State its properties.*

Blue crystals with 5Aq; odorless; readily soluble in water, insoluble in alcohol; has a disagreeable, styptic taste. When heated, the Aq is driven off, and a white substance remains, which absorbs water and resumes its blue color with great readiness. Its aqueous solution is acid, and coagulates albumen.

617. *Name some pigments containing Cu used in the arts, and give their composition.*

Scheele's green = mineral green = cupric arsenite. Schweinfurt green = mitis green = Paris green = cupric aceto-metarsenite. Verdigris = basic cupric acetate. Mineral green, azurite or mountain blue, and blue ash = basic cupric carbonates.

618. *Describe the analytical characters of the cupric salts.*

1. With H_2S , a black precipitate, insoluble in NH_4HS , soluble in hot, dilute HNO_3 .

2. With KHO or NaHO , pale-blue precipitates, insoluble in excess.

3. With NH_4HO , pale blue precipitate, forming dark-blue solution in excess.

4. With potassium ferrocyanid, chestnut-brown precipitate, insoluble in weak acids, decolorized by KHO .

5. With bright metallic Fe , in presence of an acid reaction, deposition of metallic Cu .

619. *How is copper poisoning usually occasioned?*

By the ingestion of sulfate or acetate of copper, or, more frequently, by eating food, pickles, etc., which have been cooked or allowed to stand in copper vessels. Occasionally in workers in the metal and by the use of articles of food adulterated with copper compounds.

620. *Does copper exist normally in the body?*

It does not. In analyzing bodies, traces of this metal are always found, without any history of its administration. This is, however, not "physiological copper," but has found its way into the economy with the food in small quantities. Copper sulfate is frequently added to flour

to render the bread white, and to canned vegetables for the double purpose of "greening" and preserving them.

621. *What peculiarity is noticed in the vomit in copper poisoning?*

It is blue or green in color. The green color due to copper may readily be distinguished from that produced by bile coloring matter by the addition of ammonium hydrate, which produces a deep blue color if copper is present.

622. *What treatment is indicated?*

The administration of albumen (raw white of egg), with which copper salts form an insoluble compound. Emesis or stomach pump.

623. *Give an easy clinical test for copper.*

Immerse a piece of iron (blade of a knife) into the fluid. If copper be present, it will be deposited in the metallic form. The addition of a little dilute HCl or H_2SO_4 hastens the formation of the deposit.

MERCURY.

624. *Under what other names is this element known?*

Hydrargyrum, U. S., Br.; mercurius; quicksilver.

625. *Give its symbol, valence, and atomic weight.*

Hg (Latin, Hydrargyrum). It is bivalent. 200.

626. *Of how many atoms is the molecule of mercury composed?*

One.

627. *What is the principal ore of mercury?*

A native sulfid, known as cinnabar.

628. *Give the properties of elementary mercury.*

With the exception of bromin, it is the only element liquid at ordinary temperatures. When cooled to -40° (-40° F.) it crystallizes, and when heated to 350° (662° F.) it boils; it is volatile at all temperatures above -10° . It has a bright metallic lustre. Pure mercury remains unchanged in air at ordinary temperatures. It unites directly with chlorin, bromin, and iodine.

629. *What is an amalgam?*

An alloy containing mercury.

630. *What important pharmaceutical preparations contain elementary mercury?*

Hydrargyrum cum cretâ, U. S., Br. = mercury with chalk; Massa hydrargyri, U. S. = Pilulæ hydrargyri, Br. = blue pill, blue mass; Unguentum hydrargyri, U. S., Br. = mercurial ointment.

631. *What is the purpose of the chalk, confection, and lard in these preparations?*

To "extinguish" the Hg—*i.e.*, to convert it into exceedingly minute globules which have no tendency to unite.

632. *Has liquid mercury any chemical action on the economy?*

It has not as long as it remains in that form.

633. *How is the mercury in the preparations named absorbed?*

In the manufacture of these preparations a notable quantity of the element is oxidized to mercurous oxid (a greater quantity in blue pill than in mercury with chalk); this, on contact with

the acids of the gastric juice or perspiration, is converted into compounds which are soluble, and therefore capable of absorption.

634. *With what substances is commercial mercury contaminated?*

Lead, tin, bismuth, zinc, and mechanical impurities.

635. *What is meant by mercurous and mercuric compounds?*

Like copper, mercury forms two series of compounds, in one of which the single bivalent atom Hg enters; these are the mercuric compounds, and contain the least proportionate amount of mercury. In the other, the double atom (Hg_2) enters as a bivalent group; these are the mercurous compounds.

636. *What is the formula of mercurous oxid?*

Hg_2O .

637. *How is it formed, and what are its properties?*

By digesting mercurous chlorid with solution of potassa. It is a black powder, odorless and tasteless; quite unstable; formerly officinal as "black precipitate."

638. *Give the chemical name and formula of the other oxid of mercury.*

Mercuric oxid, HgO .

639. *By what names is it known pharmaceutically?*

Hydrargyri oxidum rubrum, U. S., Br.; Hydrargyri oxidum flavum, U. S., Br.; red precipitate; red oxid of mercury.

640. *By what two processes is it prepared?*

1. By heating mercuric nitrate as long as brown.

fumes are given off, and then washing with alcohol and water. 2. By adding solution of caustic soda to solution of mercuric chlorid.

641. *Wherein do oxids prepared by these processes differ from each other?*

The oxid prepared by heat is crystalline, while the precipitated variety forms a yellowish-red, amorphous powder. The latter is much more active in its chemical and therapeutical properties than the former.

642. *Why does the ointment of this substance deteriorate on keeping?*

Because, in contact with fats and certain other organic substances, the oxid is decomposed, the organic matter being oxidized and metallic mercury remaining.

643. *Give the formula and synonyms of mercurous chlorid.*

Hg_2Cl_2 . Calomel; mild chlorid of mercury; Hydrargyri chloridum mite, U. S.; Hydrargyri subchloridum, Br.

644. *Give an account of its preparation.*

Mercuric sulfate is first formed by heating together mercury and sulfuric acid until a dry, white mass remains. This is then mixed with mercury and common salt, and again heated.

HgSO_4	+	Hg	+	2NaCl	=	Na_2SO_4	+	Hg_2Cl_2
Mercuric sulfate.		Mercury.		Sodium chlorid.		Disodic sulfate.		Mercurous chlorid.

The chlorid is volatilized and condensed in the upper part of the vessel, while the disodic sulfate remains. The chlorid is then washed with boiling water, until the washings no longer form a precipitate with ammonium hydroxid.

645. *With what substance is calomel liable to be contaminated?*

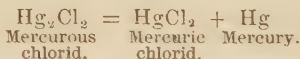
With corrosive sublimate.

646. *How may this impurity be detected?*

By placing the powder upon a bright copper surface and moistening with water. If corrosive sublimate be present, a silver-white stain is formed on the copper.

647. *Give the properties of mercurous chlorid.*

It is a heavy, white, amorphous powder; tasteless, odorless, insoluble in water. It distils without melting. When exposed to light, it is partially decomposed into mercury and corrosive sublimate:



This decomposition also takes place when mercurous chlorid is boiled for some time with water, and, more rapidly in the cold, if the water contain alkaline chlorids.

648. *Why are the mineral acids incompatible with calomel?*

Because of their tendency to decompose it, with formation of corrosive sublimate and a soluble salt of mercury with the acid. Nitromuriatic acid produces this decomposition most readily.

649. *Why are the alkaline chlorids, bromids, and iodids incompatible with calomel?*

Because in their presence there is formation of the soluble mercuric chlorid, bromid, or iodid. It has been found in naval practice that the use of salt provisions precludes the use of calomel.

650. *Why are the caustic and carbonated alkalis incompatible with calomel?*

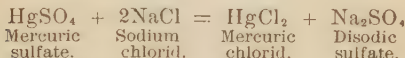
Because in their presence mercurous oxid is first formed; this is rapidly decomposed into mercurous oxid and mercury, and the former, in the presence of the alkaline chlorids of the gastric juice, is converted into corrosive sublimate.

651. *Give the formula and synonyms of mercuric chlorid.*

HgCl_2 . Hydrargyri chloridum corrosivum, U. S.; Hydrargyri perchloridum, Br.; perchlorid of mercury; bichlorid of mercury; corrosive sublimate.

652. *Give the method of its preparation.*

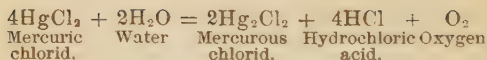
By heating together mercuric sulfate and sodium chlorid:



The chlorid volatilizes, and is condensed in the upper part of the vessel—sublimes.

653. *State its properties.*

It forms heavy, white, translucent, crystalline masses, or, when pulverized, a pure white powder (calomel has a yellowish tinge), odorless. It has a strong, acrid, styptic taste, and is soluble in 16 parts of cold or in 3 parts of boiling water, also soluble in alcohol and in ether. The aqueous solution is colorless and acid in reaction. It is decomposed by exposure to light, oxygen being given off, hydrochloric acid formed, and mercurous chlorid deposited:



The decomposition is accelerated by the presence of organic matter.

654. *What is the action of lime water upon the chlorids of mercury?*

With mercurous chlorid mercurous oxid is formed, and is then decomposed into a mixture of mercuric oxid and mercury; this reaction takes place in the preparation of "black wash." Yellow wash is obtained in a similar manner with mercuric chlorid, and holds in suspension a yellow oxychlorid.

655. *What reaction takes place between mercuric chlorid and ammonium hydroxid?*

A white precipitate is formed, which is regarded as ammonium chlorid, NH_4Cl , in which two atoms of hydrogen are replaced by one atom of mercury, $\text{NH}_2\text{Hg}''\text{Cl}$. This is the ammoniated mercury, or white precipitate, of the Pharmacopœia.

656. *Give the properties of the compound of mercuric chlorid and albumen.*

When mercuric chlorid and albumen in solution are brought together, a precipitate is formed which is insoluble in water, but is soluble in an excess of albumen, in dilute hydrochloric acid, or in solutions of alkaline chlorids.

657. *Give the formula and synonyms of mercurous iodid.*

Hg_2I_2 . Hydrargyri iodidum viride, U. S., Br.; protiodid, or green iodid of mercury.

658. *State its properties.*

It is a greenish-yellow powder, odorless, tasteless, very sparingly soluble in water. It is very readily decomposed into mercuric iodid and mercury.

659. *Give the formula and synonyms of mercuric iodid.*

HgI_2 . Hydrargyri iodidum rubrum, U. S., Br. ; red iodid, or biniodid of mercury.

660. *State its properties.*

When first formed it is yellow, but rapidly becomes scarlet. It is tasteless, odorless, permanent in air, sparingly soluble in water, but quite soluble in solutions of the chlorids, bromids, or iodids.

661. *What officinal preparation of arsenic contains mercuric iodid?*

Liquor arsenii (*sic*) et hydrargyri iodidi, U. S. P., commonly known as Donovan's solution.

662. *What is vermilion?*

Mercuric sulfid, HgS , prepared artificially.

663. *What is the composition of turpeth mineral?*

It is a basic mercuric sulfate, *i.e.*, mercuric sulfate combined with the oxid : $\text{HgSO}_4, 2\text{HgO}$.

664. *Give the analytical characters of the mercurous salts.*

1. With HCl , a white precipitate, turns black with NH_4HO .

2. With H_2S , a black precipitate, insoluble in NH_4HS , HNO_3 , or HCl .

3. With KHO , black precipitate, insoluble in excess.

4. With KI , greenish precipitate.

665. *Give the analytical characters of the mercuric salts.*

1. With H_2S , a precipitate, at first white, then orange, finally black.

2. With KHO or $NaHO$, yellow precipitate.

3. With NH_4HO , white precipitate.

4. With KI , yellow precipitate, rapidly turning salmon-colored and red, forming colorless solution with excess of precipitant.

5. With stannous chlorid, white precipitate, turning gray, and depositing globules of Hg when the liquid is boiled.

666. *How may Hg be best detected in the urine in cases of suspected poisoning?*

By the application of the Reinsch test (see Q. 345-348).

Or a small bar of Zn , around which a strip of dentists' gold foil has been spirally wound, may be immersed in the urine, acidulated with H_2SO_4 . In the presence of Hg the Au is dimmed in 24 hours, and if it be washed, dried, and heated in a tube, a sublimate is formed, which consists of microscopic globules of Hg .

667. *What kind of mercurials are capable of causing poisoning?*

All compounds soluble in water or in the digestive liquids.

668. *What compound of Hg is most frequently the cause of poisoning?*

Corrosive sublimate.

669. *Describe the prominent symptoms of acute corrosive sublimate poisoning.*

The nauseous, metallic taste is experienced during the act of swallowing. Within a few

moments this is followed by an intense, burning pain in the mouth, throat, and stomach. The mouth and tongue are whitened and shrivelled. There are vomitings of a white material, containing shreds of mucous membrane, and tinged with blood, and bloody stools. Salivation occurs if life be sufficiently prolonged. Death sometimes occurs early from collapse, accompanied by convulsions, or in deep coma; but in most fatal cases life is prolonged for from three to six days.

670. *What are the points of diagnosis between arsenical and mercurial poisoning?*

Arsenical Poisoning.

1. The symptoms rarely begin within 20 minutes.

2. Pain is usually limited to the stomach and throat.

3. The taste is very faint, sweetish, and metallic. Usually none.

4. The mouth and tongue are normal.

5. The urine contains As.

Mercurial Poisoning.

1. The symptoms begin almost immediately.

2. Pain is also severe in the mouth.

3. The taste is intensely metallic, and nauseous.

4. The mouth and tongue are whitened

5. The urine contains Hg.

671. *Give the antidote for corrosive sublimate poisoning.*

White of egg. The following precautions should be observed in its administration: Too much should not be given at one time, lest the precipitate be dissolved in the excess; the antidote should be followed by an emetic, to remove

the precipitate before it shall have been dissolved by the acid and chlorids of the gastric juice.

672. *Describe the post-mortem appearances in poisoning by $HgCl_2$.*

The salivary glands are enlarged. The tongue, mouth, œsophagus, and mucous membrane are usually shrivelled, and grayish-white in color, though sometimes they are reddened and intensely inflamed. The intestines are usually highly congested and the urinary bladder contracted and empty.

COMPOUNDS OF CARBON.

673. *Under what other name are these compounds known?*

Organic substances.

674. *What is the distinction between organic and inorganic substances?*

Any compound containing carbon is an organic compound, whether it be a constituent of a vegetable or animal body, or not. The division is simply one of convenience, and is retained owing to the great number of the carbon compounds.

675. *What are the valence, symbol, and atomic weight of carbon?*

It is bivalent and quadrivalent, its symbol is C, and its atomic weight 12.

676. *Of what four elements are organic compounds principally composed?*

Carbon, hydrogen, oxygen, and nitrogen.

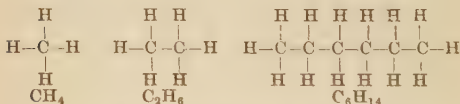
677. *What elements may enter into the composition of organic compounds?*

All the elements.

678. *What property do the atoms of carbon possess to an extraordinary degree, and what bearing has this upon organic chemistry?*

The power of combining with each other and interchanging valences, which thus equalize each other and disappear. Were it not for this property of carbon, the number of its compounds

would be very much smaller than it is. We could, for example, have but one saturated compound of carbon with hydrogen, C^vH_4 ; we have, however, a large number of such compounds, the constitution of some of which may be thus represented:



679. *What is an homologous series?*

A series of compounds, each term of which differs from the next by CH_2 , more or less.

The members of the same series are possessed of similar properties.

680. *What is a general or algebraic formula?*

An algebraic formula applicable to an entire homologous series. Thus the general formula of the substances mentioned in Q. 678 is $\text{C}_n\text{H}_{2n+2}$, and from this formula that of any member of the group may be deduced, if its position in the series be known. If, for example, the formula of the 5th in the series be required, $n = 5$, and we have $\text{C}_5\text{H}(5 \times 2) + 2$ or C_5H_{12} .

681. *What are isomeric bodies?*

Substances different in their nature and properties, but having the same percentage composition.

Thus acetic acid and methyl formate, although entirely distinct substances, endowed with very different properties, consist each of C—40; O—53.33; and H—6.67 parts in 100.

682. *How many kinds of isomerism are recognized, and how are they designated?*

Two. Metamerism and Polymerism.

683. *When are two substances said to be metameric?*

When they have the same percentage composition and also the same molecular weight. Thus methyl formate and acetic acid are metameric because they each have the percentage composition given in Ans. 681, and the molecular weight of each is 60.

684. *When are substances said to be polymeric?*

When they have the same percentage composition, but the molecular weight of one is a multiple of the molecular weight of the other. Thus methyl formate and acetic acid are polymeric with glucose, because each has the percentage composition given in Ans. 681; but, while the molecular weight of the former two is 60, that of the last is 180, or 60×3 , its formula being $C_6H_{12}O_6$.

685. *To what are the differences in properties of isomeric substances due?*

To different arrangement of the atoms, different structure of the molecules.

686. *What is understood by the terms composition and constitution?*

The composition of a substance is the number and kind of atoms of which its molecule consists. Its constitution is the intimate structure of the molecule; the relations of the atoms to each other.

687. *What are empirical formulæ?*

Formulæ indicating the composition of a substance, but not its constitution, as: H_2SO_4 , $C_2H_4O_2$.

688. *What is a radical?*

A group of atoms capable of passing unaltered from one compound to another, and in this behaving like an atom.

Example.—Let us consider the compound CH_4 as composed of CH_3H ; if we act upon this with iodine we obtain a compound CH_3I ; if we now treat this substance, under proper conditions, with potash, we obtain a compound CH_3OH ; and if we act upon this with acetic acid we obtain a compound $\text{CH}_3\text{C}_2\text{H}_3\text{O}_2$. This group CH_3 is, therefore, capable of passing from one combination to another without undergoing change itself; it is a radical. As it is composed of one atom of the quadrivalent carbon, three of whose valences are satisfied with atoms of hydrogen, there remains one free valence,

$$\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}- \\ | \\ \text{H} \end{array}$$

and the radical behaves like an atom of an univalent element $(\text{CH}_3)'$.

689. *What are meant by types?*

Common substances, the arrangement of the atoms in whose molecules may be taken as representative of whole classes of other substances whose molecules have a similar arrangement.

690. *Under what three types may organic substances be classified?*

Hydrogen, water, and ammonia. The molecule of hydrogen consists of two atoms united together, thus: $\left. \begin{array}{c} \text{H} \\ \text{H} \end{array} \right\}$. The molecule of water is

composed of two atoms of hydrogen (univalent) united to one atom of oxygen (bivalent), thus :
 $O \begin{matrix} \diagup H \\ \diagdown H \end{matrix}$, or $\begin{matrix} H \\ H \end{matrix} \} O$. The molecule of ammonia consists of three atoms of hydrogen united to one atom of nitrogen (trivalent). Under these three types (either singly or combined with each other) organic substances, whose constitution is known, can be classified.

Hydrogen Type.	Water Type.	Ammonia Type.
$\begin{matrix} H \\ H \end{matrix} \}$	$\begin{matrix} H \\ H \end{matrix} \} O''$	$\begin{matrix} H \\ H \\ H \end{matrix} \} N'''$
$\begin{matrix} (CH_3) \\ H \end{matrix} \}$ Marsh gas.	$\begin{matrix} (CH_3)' \\ H \end{matrix} \} O''$ Wood spirit.	$\begin{matrix} (CH_3)' \\ (H')_2 \end{matrix} \} N'''$ Methylamin.

691. *What are typical formulæ ?*

Formulæ partially indicating the constitution of the substance, and constructed by the substitution of a radical or radicals in one of the three types, or a combination of two of them. Thus the typical formula of acetic acid is $\begin{matrix} C_2H_3O \\ H \end{matrix} \} O$,

while that of methyl formate is $\begin{matrix} CHO \\ CH_3 \end{matrix} \} O$.

692. *What is a graphic formula ?*

A formula showing the constitution of the substance completely, *i.e.*, the relations of all of the atoms. Thus the graphic formula of acetic

acid is $\text{O}=\text{C}-\text{O}-\text{H}$, while that of methyl form-

ate is $\text{O}=\text{C}-\text{O}-\text{C}\equiv\text{H}_3$. For the sake of brevity

these formulæ are usually written $\text{CH}_3-\text{CO}, \text{OH}$ and $\text{H}-\text{COO}, \text{CH}_3$. It is obvious that the graphic formula of a substance can only be constructed when its constitution is known.

693. *What is a hydrocarbon?*

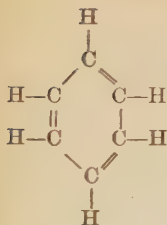
A compound containing only carbon and hydrogen.

694. *How are organic substances classified?*

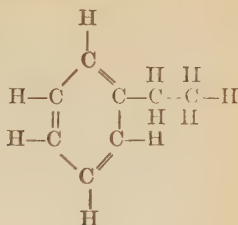
The different series of hydrocarbons form the skeleton of the classification. Other organic substances are considered as derived from them by substitution of atoms or radicals for atoms of hydrogen or carbon. These derivatives are arranged in groups, the members of which have the same chemical nature, or *function*; as acids, alcohols, ethers, etc.

695. *Into what two classes are the hydrocarbons divided, and wherein do they differ?*

The *open chain* or *acyclic*, and the *closed chain* or *cyclic*. The former contain two terminal carbon atoms attached to but one other carbon atom, as in the formula given in Ans. 678. In the latter every carbon atom is attached to at least two others, as in I. below. There also exist hydrocarbons formed by the union of acyclic with cyclic hydrocarbons or their derivatives, as in II. In these the attached acyclic portion is designated a *lateral chain*.



I.



II.

696. Name and give graphic formulae of the three series of acyclic hydrocarbons.

I. The *Paraffin* or *Methane* series, the formula of one of which is: $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$.

II. The *Olefin* or *Ethene* series, the formula of one of which is: $\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_3$.

III. The *Acetylene* or *Ethine* series, the formula of one of which is: $\text{CH}-\text{C}-\text{CH}_2-\text{CH}_3$

ACYCLIC HYDROCARBONS.

SATURATED HYDROCARBONS. C_nH_{2n+2} .

Paraffin or Methane Series.

697. *What is a saturated compound?*

One in which all the possible valences of the constituent elements are satisfied, as in $C^{iv}H'_4$.

698. *What name is applied to the members of this series, and why?*

Paraffins, from parum = little, and affinis = affinity; because they are substances which have little tendency to enter into chemical reaction.

699. *What is the composition of the radical methyl?*

CH_3 .

700. *What does the termination yl indicate?*

That the name refers to a radical. Thus methyl, CH_3 ; hydroxyl, OH ; acetyl, C_2H_3O , etc.

701. *Give the formula and synonyms of methyl hydrid?*

CH_4 . It is also known as Marsh gas, fire damp, light carburetted hydrogen.

702. *Describe its properties.*

It is a colorless, odorless, tasteless gas, lighter than air, sparingly soluble in water; burns with a yellow flame; forms explosive mixtures with air and oxygen. A large quantity of carbon dioxide is formed in an explosion of such a mixture, and is known to miners as "after-damp."

703. *What natural product is composed mainly of saturated hydrocarbons?*

Petroleum. [The terms of this series vary

regularly as to their boiling point, from the lowest, which is gaseous at ordinary temperatures, to the 16th, which only boils at about 280° (536° F.). A petroleum is liable to explode in proportion as it contains hydrocarbons of low boiling point.]

704. *Name some of the products obtained from petroleum.*

Petroleum ether or rhigolene, gasolin, benzin, kerosene, lubricating oils, paraffin, vaselin.

705. *What are the properties and uses of petroleum ether?*

It is a colorless liquid, sp. gr. 0.7, highly inflammable, boils at 21° (70° F.). It is used as a substitute for sulfuric ether to produce cold by its rapid evaporation, and as a solvent.

706. *What are the properties and uses of paraffin?*

It is a white, crystalline solid, fusible at 45° – 65° (113° – 149° F.), used in the manufacture of candles and to protect glass and other surfaces from the action of acids, alkalies, etc.

707. *What is vaselin, and what are its properties and uses?*

It is a mixture of paraffin with lubricating oils. It varies in consistence according to the proportions of the constituents, but has usually the consistence of butter. It is acted upon by chemical agents with great difficulty. It is used in pharmacy (Petrolatum, U. S.) and in perfumery for the purposes formerly served by the animal fats, over which it has the advantage of never becoming rancid.

HALOID DERIVATIVES OF THE PARAFFINS.

708. *What is understood by substitution?*

The replacement of an atom or atoms of one

element for an equivalent number of atoms of another element in a compound. Example: The compound CH_4 being saturated, it is impossible to introduce any other atom into its molecule without, at the same time, displacing therefrom one or more of its atoms. Acting upon CH_4 with chlorin, it is possible to remove each of the atoms of hydrogen and *substitute* therefor atoms of chlorin, forming the substituted compounds CH_3Cl ; CH_2Cl_2 ; CHCl_3 ; CCl_4 .

709. *What important substance results from the substitution of three atoms of chlorin for atoms of hydrogen in methyl hydrid?*

Chloroform, which is chlorid of bichlorinated methyl, $\left. \begin{array}{l} \text{CHCl}_2 \\ \text{Cl} \end{array} \right\}$.

710. *State its physical properties.*

It is a colorless, volatile liquid, having an agreeable, ethereal odor, and a sweet taste. It is heavier than water, with which it does not mix; it mixes in all proportions with alcohol and ether. It boils at $60^\circ.8$ ($141^\circ.4$ F.). It can only be ignited with difficulty. It is a good solvent for fats, gutta-percha, and many substances rich in carbon.

711. *How is chloroform tested for impurities?*

When used for inhalation it should respond to the following tests: Its sp. gr. should be 1.49. When shaken with an equal volume of colorless H_2SO_4 the mixture should not become hot, and after twenty-four hours the upper (CHCl_3) layer should be absolutely colorless, while the acid layer should have only a pale yellow tinge. When thrown upon H_2O it should sink in transparent drops, and the water should not become

milky. When evaporated, the last portions should have no pungent odor, and the remaining film of moisture should have no taste or odor other than that of chloroform.

712. *How may CHCl_3 be detected?*

With alcoholic solution of KHO and a few drops of anilin it gives off a disagreeable odor, resembling that of witch hazel, when heated.

(See Manual, pp. 234, 235.)

713. *How are bromoform and iodoform related to chloroform?*

They have the same constitution, bromin or iodine replacing the chlorine:



714. *State the principal properties of iodoform.*

It forms yellow crystals, having a strong, disagreeable odor. Insoluble in water, soluble in alcohol. It contains 96 per cent. of its weight of iodine.

MONOATOMIC ALCOHOLS.

715. *What is an alcohol?*

A hydroxid containing a hydrocarbon radical and capable of reacting with an acid to produce a compound ether (see Q. 757) and water.

The alcohols are the counterparts of the metallic hydroxids, while the compound ethers are the counterparts of the metallic salts.

716. *What is meant by the atomicity of an alcohol?*

The saturating power of its radical. Thus $(\text{C}_3\text{H}_7)' \left\{ \begin{array}{l} \text{H} \\ \text{O} \end{array} \right.$ is a monoatomic alcohol ;

$(\text{C}_3\text{H}_6)'' \left. \begin{array}{c} \text{H}_2 \\ \text{H}_2 \end{array} \right\} \text{O}_2$ is a diatomic alcohol, and

$(\text{C}_3\text{H}_5)''' \left. \begin{array}{c} \text{H}_3 \\ \text{H}_3 \end{array} \right\} \text{O}_3$ is a triatomic alcohol.

717. *What group of atoms is characteristic of primary alcohols, and what are their products of oxidation?*

CH_2OH . Their products of oxidation are: first, an aldehyde, and, by more complete oxidation, an acid containing the same number of carbon atoms as the alcohol. Thus the primary

alcohol $\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CH}_3 \end{array}$ yields by oxidation, first the
 $\begin{array}{c} \text{CHOH} \\ | \\ \text{CH}_3 \end{array}$ aldehyde and then the acid $\begin{array}{c} \text{COOH} \\ | \\ \text{CH}_3 \end{array}$

718. *What group of atoms is characteristic of a secondary alcohol, and what is produced from it by oxidation?*

CHOH . A ketone or acetone. Thus the
 secondary alcohol $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CHOH} \\ | \\ \text{CH}_3 \end{array}$ produces the ketone

$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CO} \\ | \\ \text{CH}_3 \end{array}$ by oxidation.

719. *What group of atoms is characteristic of a tertiary alcohol, and what are its products of oxidation?*

COH. When oxidized, it produces two acids or ketones, each containing a less number of carbon atoms than the original alcohol.

(See Manual, pp. 227-240.)

720. Give the empirical, typical, and graphic formulæ, and the names of methyl alcohol.

CH_3O ; CH_3 } O ; $\begin{array}{c} \text{CH}_3\text{H} \\ | \\ \text{H} \end{array}$ Methylic alcohol,

wood alcohol, pyroxylic spirit, carbinol.

721. From what source is methyl alcohol obtained commercially?

It is one of the products of the distillation of wood.

722. What is methylated spirit?

Spirits of wine containing ten per cent. of wood spirit. This does not interfere with its use in the arts, but communicates a disagreeable taste and odor which prevent its being taken internally.

723. Give the empirical, typical, and graphic formulæ, and the names of ethyl hydroxid.

$\text{C}_2\text{H}_5\text{O}$; C_2H_5 } O ; $\begin{array}{c} \text{CH}_2\text{OH} \\ | \\ \text{CH}_3 \end{array}$ Ethylic alcohol,

vinic alcohol, alcohol, spirits of wine, methyl carbinol.

724. From what substance is alcohol usually obtained?

From starch.

725. Describe briefly the method of obtaining alcohol from starch.

The process is divisible into three parts: 1. The grain is malted, i.e., it is caused to germinate. In this stage of the process, a peculiar substance, called *diastase*, is produced, which causes the

transformation of starch into glucose. 2. The saccharine liquid is brought in contact with *yeast*, a plant whose nutrition is attended with *fermentation*, by which glucose is decomposed into alcohol and carbon dioxid: $C_6H_{12}O_6 = 2C_2H_5O + 2CO_2$. 3. The alcohol is more or less perfectly separated from other substances by distillation.

726. *Explain the difference between the various kinds of ethyl alcohol used in the arts and in pharmacy.*

They differ from each other mainly in the proportion of alcohol and water.

Absolute alcohol is pure alcohol, C_2H_5O . [It is obtained with difficulty, and deteriorates rapidly, owing to its great tendency to absorb water. The so-called absolute alcohol of the shops is seldom stronger than 98 per cent.]

Alcohol, U. S.—Stronger alcohol. Has a specific gravity of 0.820, and contains 94 per cent. alcohol. *Spiritus rectificatus, Br.*, sp. gr. 0.838, contains 84 per cent. of alcohol.

Alcohol dilutum, U. S. = Spiritus tenuior, Br., is of sp. gr. 0.920, and contains 53 per cent. alcohol.

Proof spirit—Spirits of wine—contains 49 per cent. alcohol.

727. *State the principal properties of alcohol.*

It is a colorless, mobile fluid, having, when pure, specific gravity 0.794, and boiling point 78° ($172^\circ.5$ F.). It has a peculiar odor and a sharp, burning taste; very volatile. It has a great attraction for water, and to this are due its coagulating action on albumen and its preservative action on animal substances. It is a very useful solvent.

728. *What is the alcoholic strength of "spirituous liquors"?*

From 53 to 56 per cent. absolute alcohol

729. *Mention the sources of some of the principal spirits.*

Brandy (Spir. vini Gallici, U. S., Br.) is obtained by distilling wine. Rum, by fermenting and distilling molasses. American whiskey, *Spiritus frumenti*, U. S., from rye, wheat, or Indian corn. Irish and Scotch whiskey, from barley. [The peculiar smoky flavor is produced by drying the grain over a peat fire.] Gin is obtained from various grains, and is flavored with juniper berries.

730. *Wherein do wines differ from spirits?*

In that they contain a smaller proportion of alcohol, and, as they are not distilled, in containing a variety of solid substances, present in the juice of the grape, which do not exist in spirits.

731. *What is the alcoholic strength of "light" wines?*

From 7 to 14 per cent.

732. *Of heavy wines?*

From 14 to 21 per cent.

733. *What is the alcoholic strength of malt liquors?*

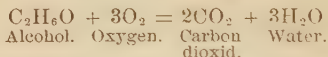
From $1\frac{1}{2}$ to 9 per cent.

(See Manual, pp. 245-248.)

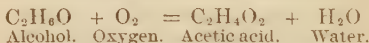
734. *Describe the various products of the oxidation of alcohol.*

These vary according as the oxidation is rapid or slow. If the oxidizing agent be energetic, as

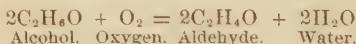
chromic anhydrid, the alcohol burns, and is converted into carbon dioxid and water :



If the oxidation take place more slowly, it is limited to the substitution of an atom of oxygen for two of hydrogen, forming acetic acid :



If the action take place still more slowly, aldehyde is formed :



For tests for alcohol, see Manual, pp. 243, 244.

735. *Give the formula and synonyms of amyl hydioxid.*

$\begin{array}{c} \text{C}_5\text{H}_{11} \\ \text{H} \end{array} \left. \vphantom{\begin{array}{c} \text{C}_5\text{H}_{11} \\ \text{H} \end{array}} \right\} \text{O.}$ Amyl alcohol, fusel oil, grain oil, potato spirit.

The composition of "fusel oil" varies with the different spirits, and contains propylic, butylic, and hexylic alcohols as well as amylic.

736. *What practical interest attaches to it?*

It is produced in small quantities along with varying quantities of propyl, butyl, and hexyl alcohols, in alcoholic fermentation, and, as it has deleterious properties, must be carefully separated from the spirits. The separation is, however, never complete, nor should it be, as the substances to which a properly aged spirit owes

its flavor are formed by the gradual oxidation of these alcohols.

SIMPLE ETHERS.

737. *What substance is formed by substituting for the remaining extraradical hydrogen of alcohol the radical ethyl?*

Oxid of ethyl, or ethylic ether, $\left. \begin{matrix} (C_2H_5)' \\ (C_2H_5)' \end{matrix} \right\} O = C_4H_{10}O$, commonly known as "sulfuric ether."

738. *To what substances does the name ether apply?*

To all substances produced by the action of an acid upon an alcohol.

739. *What are simple, mixed, and compound ethers?*

Simple and mixed ethers are oxids of the alcoholic radicals, the radicals being the same in the simple ethers and different in the mixed ethers. Compound ethers are acids in which the hydrogen has been replaced by hydrocarbon radicals.

Thus $\left. \begin{matrix} CH_3 \\ CH_3 \end{matrix} \right\} O$ is a simple ether, $\left. \begin{matrix} CH_3 \\ C_2H_5 \end{matrix} \right\} O$ a mixed ether, and $\left. \begin{matrix} C_2H_5O \\ CH_3 \end{matrix} \right\} O$ a compound ether.

740. *Why is the name "sulfuric ether" improper as applied to ethyl oxid?*

Because it contains no sulfur. The name properly applies to another substance:

$\left[\left. \begin{matrix} SO_2 \\ (C_2H_5)_2 \end{matrix} \right\} O_2 \right]$ It should be called ethylic ether.

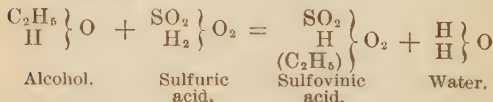
741. *Describe the manufacture of ether.*

A mixture of H_2SO_4 and alcohol is maintained

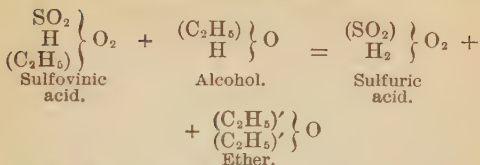
at a temperature of 140° (284° F.), in a retort into which flows a slow, but constant, stream of alcohol, and which is connected with a suitable condenser. The first distillation yields a mixture of $C_4H_{10}O$, C_2H_6O , and small quantities of H_2SO_4 . To purify the ether, this mixture is shaken with milk of lime and H_2O . Upon standing, the ether, purified from H_2SO_4 and C_2H_6O , rises to the surface and is decanted. This product is known as "washed ether," and still contains H_2O , which is removed by the addition of calcium oxid and redistillation. As thus purified, it forms the *Æther fortior*, U. S.; *Æther purus*, Br.

742. *Explain the conversion of alcohol into ether.*

A small quantity of H_2SO_4 is capable of etherifying a large quantity of C_2H_6O . This was one of the processes formerly explained (?) by the empty word "catalysis." One molecule of H_2SO_4 and one of C_2H_6O first act upon each other, the ethyl of the C_2H_6O replacing an atom of hydrogen of the acid, with formation of a substance called sulfovinic acid :



As soon as the sulfovinic acid is formed it reacts, molecule for molecule, with alcohol, giving up again the radical ethyl, which replaces the extra-radical hydrogen of the alcohol, while H_2SO_4 is regenerated :



743. *State the properties of ethylic ether.*

It is a colorless, mobile liquid, having a peculiar and tenacious odor ; it is lighter than H_2O , in which it is only slightly soluble. It boils at 35° (95° F.) at ordinary barometric pressure, and is very volatile at all temperatures. It is highly inflammable, and its vapor forms an explosive mixture with air. It is an excellent solvent of fats, resins, alkaloids, etc.

744. *What precautions are to be observed to guard against ignition of ether?*

That it be used at a distance from lights and fires. The vapor of ether is heavier than air, and more danger is therefore to be apprehended from a grate fire than from a chandelier. In administering ether at night, the light should be held well above the patient.

MONOBASIC ACIDS. $\text{C}_n\text{H}_{2n}\text{O}_2$.

745. *Explain the formation of the monobasic acids from the corresponding alcohols.*

They are produced by the substitution of an atom of oxygen for H_2 in the group CH_2OH of the primary alcohol. Thus the graphic formulæ of ethylic alcohol and acetic acid are :



746. *What group of atoms is characteristic of organic oxyacids?*

COOH. The basicity of the acid depends upon the number of such groups which it contains. Thus acetic acid, $\begin{array}{c} \text{COOH} \\ | \\ \text{CH}_3 \end{array}$, is monobasic ;

$\begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array}$ oxalic acid, $\begin{array}{c} | \\ \text{COOH} \end{array}$, is dibasic, etc.

747. *Under what other name is the series of monobasic acids known, and why?*

The volatile, fatty acids. So called because the lower members are volatile liquids, while the higher terms are important constituents of the animal fats.

748. *What acid of this series is obtained from ethylic alcohol?*

Acetic acid = $\begin{array}{c} \text{COOH} \\ | \\ \text{CH}_3 \end{array}$ = Acidum aceticum,

U. S., Br.

749. *How is the pure acid designated, and what are its properties?*

Glacial acetic acid ; Acidum aceticum glaciale, U. S., Br. A colorless liquid, which solidifies to an ice-like mass at 17° (62.6°F.), and boils at 119° (246.2°F.). It has a pungent odor and a pure acid taste and acid reaction. It attracts moisture from the air, and should be kept in well-

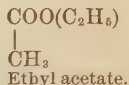
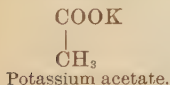
closed bottles. The commercial acid usually contains about 35 per cent. $C_2H_4O_2$.

750. *What is the composition of vinegar, and how is it obtained?*

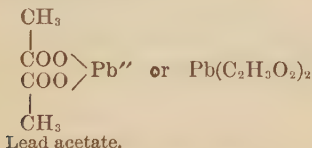
It is dilute acetic acid, holding in solution the soluble constituents of the liquid from which it is obtained. It is prepared by the oxidation of some substance containing alcohol, as wine, cider, or infusion of malt, as a result of the processes of nutrition of an organized ferment, known as *mother of vinegar* or *mycoderma aceti*.

751. *What are the salts and ethers of acetic acid called, and what is their constitution?*

Acetates. Acetic acid is monobasic, therefore acetates of the univalent metals and radicals have the constitution :



while those of the bivalent metals are formed by one atom of the metal replacing the hydrogen of two molecules of acid ;



752. *Where does butyric acid occur in nature?*
In milk and butter in combination ; also in the

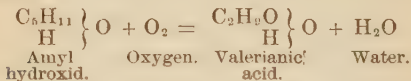
perspiration, muscular fluid, contents of the intestine, and in the products of putrefaction.

753. *Explain the formation of free butyric acid in the intestine.*

It is formed in part by the decomposition of butyrates contained in certain fats, but the greater quantity has its source from the saccharine elements of food, which are, to a certain extent, first converted into lactic acid, and this into butyric acid.

754. *Give the formula, occurrence, and method of artificial preparation of valerianic acid.*

$\text{C}_5\text{H}_9\text{O} \left\{ \begin{array}{l} \text{C}_5\text{H}_9\text{O} \\ \text{H} \end{array} \right\} \text{O}$. It occurs in valerian root, but is more easily obtained by the oxidation of amylic alcohol :



755. *What valerianates are officinal?*

Those of sodium, ammonium, zinc, and quinin.

756. *What other acids of this series occur in combination in the animal economy?*

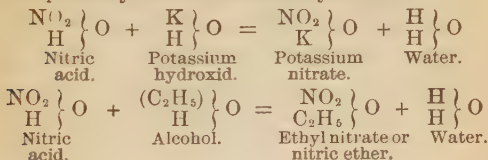
Caproic, $\text{C}_6\text{H}_{11}\text{COOH}$; caprylic, $\text{C}_7\text{H}_{13}\text{COOH}$; capric, $\text{C}_8\text{H}_{17}\text{COOH}$; myristic, $\text{C}_{13}\text{H}_{27}\text{COOH}$; palmitic, $\text{C}_{15}\text{H}_{31}\text{COOH}$; and stearic, $\text{C}_{17}\text{H}_{35}\text{COOH}$.

COMPOUND ETHERS.

757. *What is a compound ether?*

A substance resembling a salt, the difference

being that the hydrogen of the acid is replaced by a hydrocarbon radical in place of by a metal. The alcohols behave towards the acids in a manner precisely like the metallic hydroxids :



See Q. 715.

758. *What is the formula of nitrous ether, and in what officinal preparation does it exist?*

$\text{NO} \begin{pmatrix} \\ (\text{C}_2\text{H}_5) \end{pmatrix} \text{O}$. Spiritus ætheris nitrosi, U. S.
Br. Sweet spirits of nitre is a solution of this substance in alcohol.

759. *What is the composition of the true sulfuric ether?*

$\text{SO}_2 \begin{pmatrix} \\ (\text{C}_2\text{H}_5)_2 \end{pmatrix} \text{O}_2$ = ethyl sulfate.

760. *Name some of the compound ethers used in medicine, and give their formulæ.*

Ethyl acetate = Æther aceticus, U. S. ;
 $\text{C}_2\text{H}_3\text{O}_2 \begin{pmatrix} \\ (\text{C}_2\text{H}_5) \end{pmatrix} \text{O}$. Amyl nitrite = amyl nitris, U. S. ;
 $\text{NO} \begin{pmatrix} \\ (\text{C}_5\text{H}_{11}) \end{pmatrix} \text{O}$. Spermaceti = cetaceum, U. S.,
 Br., consists essentially of cetyl palmitate,
 $\text{C}_{16}\text{H}_{31}\text{O} \begin{pmatrix} \\ \text{C}_{18}\text{H}_{33} \end{pmatrix} \text{O}$.

ALDEHYDES.

761. *What are aldehydes ?*

They are substances produced from alcohols by a degree of oxidation limited to the removal of hydrogen, without introduction of oxygen. The name is a corruption of *alcoholum dehydrogenatum*.

762. *Explain by graphic formulæ the relations of the aldehydes to the alcohols and acids.*



Ethyl
alcohol.



Acetic
aldehyde.



Acetic
acid.

It appears from these formulæ that the aldehydes are intermediate between the alcohols and the acids, into the former of which they are readily converted by the introduction of H_2 , and into the latter by oxidation.

763. *Describe the properties of acetic aldehyde.*

It is a colorless, mobile liquid, having a strong, suffocating odor; boils at 21° ($69^\circ.8$ F.); soluble in all proportions in water, alcohol, and ether. Taken internally it produces rapid and deep intoxication. It is readily converted into a polymere, *paraldehyde*, $\text{C}_6\text{H}_{12}\text{O}_3$, a substance liquid above $10^\circ.5$ ($50^\circ.9$ F.), but crystalline below that temperature.

764. *Explain the relation between chloral and aldehyde.*

Chloral is aldehyde in which H_2 has been

replaced by Cl_3 , therefore *trichloraldehyde*
 COH

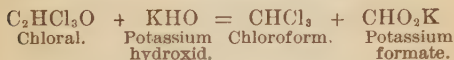


765. *Describe the properties of chloral.*

A colorless, oily liquid, having a penetrating odor and an acrid, caustic taste; sp. gr. 1.5; boils at $94^\circ.4$ ($201^\circ.9$ F.); very soluble in water, alcohol, and ether. With a small quantity of water, chloral combines to form a crystalline hydrate, $\text{CCl}_3\text{COH}, \text{H}_2\text{O}$.

766. *What reaction takes place between chloral or its hydrate and the alkalies?*

When the two are brought together the mixture becomes milky, and after a time separates into two layers, the lower of chloroform, and the upper a solution of an alkaline formate:



767. *Describe the prominent symptoms of acute chloral poisoning.*

Deep sleep, with the vessels of the head and neck greatly congested, accelerated pulse, widely dilated pupils, and deep though irregular respiration. Later the face becomes blanched and livid, the pupils contracted, the circulation and respiration fail, and the temperature falls. In some cases death occurs in from one-quarter to one hour in a condition of collapse. The usual fatal period is 8-10 hours.

768. *What treatment is indicated in acute chloral poisoning?*

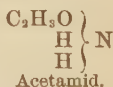
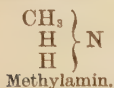
Stomach pump. Artificial respiration, flagellation, faradism (strychnin cautiously?).

(For ACETALS, KETONES (ACETONES), and NITROPARAFFINS, see Manual, pp. 271-273.)

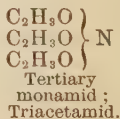
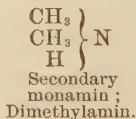
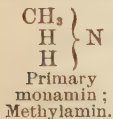
AMINS, MONAMINS (AMIDOPARAFFINS), AND MONAMIDS.

769. *What are amins and amids ?*

Substances derivable from ammonia by substitution of hydrocarbon, or of oxidized radicals for a portion or all of the hydrogen. If the substituted radicals be hydrocarbon, the substance is an *amin*; if oxidized, an *amid*.



If the substitution occur in a single molecule of ammonia, and the radical or radicals be univalent, the substance is a *monamin* or *monamid*. If it contain a single substituted radical, it is a *primary* monamin or monamid; if two, *secondary*; and if three, *tertiary*:



The amins are also known as *compound ammonias*, as they are substances capable of behaving

toward acids, in the same way as ammonia, to form hydroxids and salts :

$\text{H}_4\text{N}, \text{OH}$
Ammonium hydroxid.

$(\text{CH}_3)_4\text{N}, \text{OH}$
Tetramethylammonium
hydroxid.

$\text{H}_4\text{N}, \text{Cl}$
Ammonium chlorid.

$(\text{CH}_3)_4\text{N}, \text{Cl}$
Tetramethylammonium
chlorid.

770. *Where does trimethylamin exist in nature?*

It occurs, associated with monomethylamin and dimethylamin, in cod-liver oil, guano, in many vegetable substances, in herring pickle. It is produced, along with several other amins, in putrefaction of fish, starch paste, brain tissue, muscular tissue, and albuminoid substances, and exists, accompanied by more active alkaloids, in blood serum, etc., which have served for the culture of various bacteria.

771. *Describe the properties of trimethylamin.*

An oily liquid, having a disagreeable odor of fish ; boils at 8° ($48^\circ.2 \text{ F.}$) ; alkaline, soluble in H_2O , alcohol, and ether. It combines with acids to form crystallizable salts.

772. *Where does cholin exist in nature, and how is it produced?*

It occurs in hops, fungi, certain seeds, human placenta, bile, and yolks of eggs. It is produced by the decomposition of lecithin (see Q. 915) and during the first 24-48 hours of putrefaction of animal tissues.

773. *Describe the properties of cholin.*

A thick syrup, soluble in H_2O and in alcohol ;

strongly alkaline in reaction ; is a strong base, forming crystalline salts. When heated it splits up into glyocol (q. v.) and trimethylamin. It is poisonous only in large doses. It is isomeric, but not identical with neurin. (See below, and Manual, pp. 276, 277.)

774. *What vegetable alkaloids are monamins?*

Amanitin and muscarin, both existing in poisonous fungi. The latter is also a product of putrefaction. Both are poisonous.

775. *What other monamins are produced during putrefaction?*

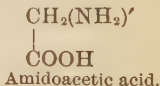
Neurin, a substance isomeric with cholin, but more actively poisonous.

(For MONAMIDS see Manual, pp. 278, 279.)

AMIDO ACIDS.

776. *What are amido acids?*

They are substances, partly acid and partly basic in function, produced from the acids by the substitution of the group (NH_2) for an atom of H in the radical. Thus :



777. *Under what other names is amidoacetic acid known?*

Glycin, glyocol, glycocin, gelatin sugar.

778. *How does it occur in the body?*

It is not found in the economy as such, but

enters into the composition of a peculiar acid, which is found as its sodium salt in the bile, and is known as glycocholic acid.

779. *What other peculiar acid is found in human bile?*

Taurocholic acid ; also in the form of its sodium salts.

780. *Describe the Pettenkofer test for the biliary acids.*

Add to the pure aqueous solution of the acids, or of their salts, one or two drops of a solution of cane sugar (1-4) ; agitate ; float this liquid carefully upon concentrated H_2SO_4 ; a turbid zone is formed at the junction of the two layers, soon replaced by a deep purple zone which gradually extends upward and downward.

781. *To what substance is this reaction due?*

Cholic acid, formed by the decomposition of the taurocholate or glycocholate.

782. *Why is Pettenkofer's reaction not available for the clinical detection of biliary salts in the urine?*

As the same appearances are produced, under the same conditions, by many other substances, the test is only reliable when applied to a simple aqueous solution of the biliary salts. The preparation of such a solution from the urine can only be accomplished by an elaborate process. No reliance is to be placed upon indications obtained by application of the test directly to the urine.

783. *Under what other name is amidocaproic acid known, and what is its constitution?*

Leucin. $\text{C}_6\text{H}_{10}(\text{NH}_2)\text{O} \left\{ \begin{array}{l} \text{H} \\ \text{O} \end{array} \right.$

784. *Where does it occur, and how is it formed?*

It exists in most glandular organs. It has not been detected in the blood or urine in health, but appears in the latter fluid in yellow atrophy of the liver. It results from the decomposition of albuminoid substances by the action of strong alkalies or acids, and during putrefaction. In the body it is formed during the processes of nutrition, and is subjected to further change. It is not eliminated in health.

(For a more complete account of these substances and of the BETAÏNS, AMIDINS, ALDEHYDINS, and HYDRAZINS, see Manual, pp. 280-291.)

AZOPARAFFINS, NITRILS, CYANOGEN COMPOUNDS.

785. *What does the syllable azo indicate?*

That the substances are derivatives obtained from the hydrocarbons by the substitution of an atom or atoms of nitrogen. Thus hydrocyanic acid, CNH , may be considered as methane, CH_4 , in which H_3 is replaced by N . Azobenzene consists of two molecules of benzene, C_6H_6 , united, with loss of two atoms of hydrogen, by two atoms of nitrogen, $\text{C}_6\text{H}_5 - \text{N} = \text{N} - \text{C}_6\text{H}_5$.

786. *What does the syllable nitro indicate?*

That the substance contains the substituted group $(\text{N}^\vee\text{O}_2)'$. Thus nitrobenzene is derived from benzene, C_6H_6 , by substitution of $(\text{NO}_2)'$ for H : $\text{C}_6\text{H}_5.\text{NO}_2$.

787. *What does the syllable amido indicate?*

That the substance contains the substituted group $(\text{N}'''\text{H}_2)'$. Thus amidoacetic acid (glycocol, see Q. 773) is derived from acetic acid,

CH_3COOH , by substitution of NH_2 for $\text{H} : \text{CH}_2 - (\text{NH}_2)\text{COOH}$.

788. *What is the composition and valence of the radical cyanogen?*

(CN). Univalent.

789. *Give the formula, proper name, and properties of cyanogen gas.*

$\begin{matrix} \text{CN} \\ \text{CN} \end{matrix} \} = (\text{CN})_2$. Dicyanogen. At ordinary temperatures a colorless gas, having a penetrating odor of bitter almonds; very irritating to the eyes and air passages; very poisonous; soluble in water, alcohol, or ether.

790. *Give the formula and synonyms of hydrogen cyanid.*

$\begin{matrix} \text{CN} \\ \text{H} \end{matrix} \}$. Hydrocyanic or prussic acid; azomethane (see Q. 782, and nitrils Q. 803).

791. *What is the strength of Acid. Hydrocyan. Dil., U. S. P.?*

Two per cent. of anhydrous acid.

792. *What are its characters?*

A colorless liquid, having an odor of bitter almonds and a bitter taste; very prone to decomposition, especially when exposed to light. Highly poisonous.

793. *What other substances contain hydrocyanic acid?*

Oil of bitter almonds; bitter-almond water; cherry-laurel water; wild-cherry bark, and the kernels of the peach, plum, etc.

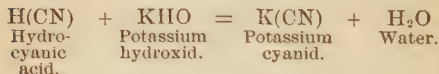
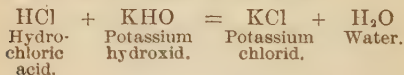
794. *Explain the formation of hydrocyanic acid in oil of bitter almonds.*

It does not pre-exist in the almonds, but is

formed by the reaction of two substances, known as amygdalin and emulsin (the former does not exist in sweet almonds). This reaction takes place in the preparation of the oil, or, when bitter almonds are eaten, in the mouth and stomach.

795. *Explain the constitution of the cyanids.*

Hydrogen cyanid is an acid, and behaves in a manner similar to hydrochloric acid :



796. *State the properties and uses of potassium cyanid.*

Hard, dull white, amorphous solid, having an odor of bitter almonds, and an alkaline taste ; very soluble in water, sparingly in alcohol. It is decomposed by even the weak acids, with liberation of hydrocyanic acid, and is consequently very poisonous. It is used largely in photography and in electro-plating.

797. *How is silver cyanid prepared, and what are its characters?*

By passing hydrocyanic acid through a solution of silver nitrate to saturation, and washing the precipitate. A tasteless, white powder ; insoluble in water, but soluble in solution of potassium cyanid.

798. *Explain its use in pharmacy.*

To prepare extemporaneously a solution of hy-

drocyanic acid of known strength. Take 8.3 grams pure HCl , of sp. gr. 1.16, and dilute with water to make 98 c.c.; add to this 9.925 grams silver cyanid; the resulting fluid, separated from the silver chlorid by filtration, contains 2 per cent. HCN . [The materials must be pure, and the weighings accurate.]

799. *Describe the tests for hydrocyanic acid or a cyanid.*

1. With AgNO_3 a white precipitate, soluble in solutions of the cyanids or of the thiosulfates. 2. Add NH_4HS ; evaporate to dryness; add Fe_2Cl_6 solution: a red color. 3. Add KHO solution and then solution of FeSO_4 containing $(\text{Fe}_2)(\text{SO}_4)_3$; a green precipitate, which forms a blue solution with HCl . 4. Moisten filter paper with freshly prepared tincture of guaiac, dip the paper into very dilute solution of CuSO_4 , and, after drying, moisten with the solution to be tested: a deep blue color.

800. *Describe the symptoms of hydrocyanic acid poisoning.*

Its action is always rapid. Relatively small doses cause an immediate sense of constriction of the throat, followed in one to two minutes by sense of pressure in the head, vertigo, confusion of intellect, and loss of muscular power. The pulse is quick, the respiration slow and stertorous. Tetanic convulsions and involuntary discharges of urine and fæces occur, followed by paralysis. Death follows, in from two hours to two days, from asphyxia. When large doses are taken no subjective symptoms are observed. The patient loses consciousness in less than one minute.

There is a short convulsive seizure, usually accompanied by evacuations of fæces, after which the patient lies perfectly still, with no sign of life, save an almost imperceptible pulse and infrequent spasmodic respiratory efforts, in which inspiration is short and expiration protracted. Death follows in from five to twenty minutes.

801. *What treatment should be followed in poisoning by hydrocyanic acid?*

There is no time for administration of antidotes. The patient should be stripped, and cold water dashed upon the head and spine, which are then rubbed dry with warm towels, and the cold douche repeated, after which artificial respiration should be practised. Inhalations of chlorin or ammonia, largely diluted with air, are recommended.

802. *What substances other than hydrocyanic acid cause cyanic poisoning?*

Potassium cyanid, mercuric cyanid, bitter almonds in sufficient quantity, oil of bitter almonds, and cherry laurel water.

803. *What are the nitrils?*

The hydrocyanic ethers of the monoatomic alcoholic radicals. Thus: CH_3, CN is methyl cyanid, or acetonitril. Hydrocyanic acid itself may be considered as formonitril, HCN . (See Manual, pp. 293, 294.)

804. *Describe the constitution of cyanic acid and the relation of its ammonium salt to urea.*

The empirical formula is CNOH , corresponding to which are two isomeric compounds: the normal, $\text{N}\equiv\text{C}-\text{OH}$, and the iso, $\text{O}=\text{C}=\text{N}-\text{H}$. Ammonium isocyanate, $\text{O}=\text{C}=\text{N}-\text{NH}_4$, is con-

verted by heat into urea, which has the same empirical formula, CON_2H_4 , but differs in constitution, having the graphic formula $\text{H}_2\text{N}-\text{CO}-\text{NH}_2$.

805. *What compound containing sulfur corresponds to cyanic acid, and of what physiological and analytical interest is it?*

Thiocyanic acid, NCSH . It exists in the saliva in combination. The free acid is actively poisonous. Its ammonium or potassium salt is used as a test for the ferric compounds, with which it gives a deep red color, discharged by HgCl_2 .

806. *What are the metalocyanids?*

Compounds of cyanogen with certain metals, which form salts, in which the analytical characters of the metals are completely masked. The best known are those containing iron, as potassium ferrocyanid, $\text{K}_4[(\text{CN})'_6\text{Fe}'']^{IV}$, = yellow prussiate of potash; potassium ferricyanid, $\text{K}_6[(\text{CN})_{12}(\text{Fe}_2)^{VI}]^{VI}$, = red prussiate of potash; ferric ferrocyanid, or Prussian blue; ferrous ferricyanid, or Turnbull's blue. There are also cobaltcyanids, platinocyanids, argentocyanids, etc.

(For HYDROXYLAMIN DERIVATIVES and SULFUR DERIVATIVES, etc., see Manual, pp. 296-300.)

ACRYLIC SERIES OF ACIDS.

807. *How do acids of this series differ from those of the acetic series in composition?*

They contain two atoms of hydrogen less, their general formula being $\text{C}_n\text{H}_{2n-2}\text{O}_2$.

808. *What two acids of this series are of medical interest?*

Crotonic acid, $C_4H_6O_2$, and oleic acid, $C_{18}H_{34}O_2$.

809. *Mention the points of interest of crotonic acid.*

It exists, in combination with glycerol, as an ether in croton oil. The aldehyde corresponding to this acid, C_4H_6O , furnishes a chlorinated derivative similar to chloral, a hydrate of which is used medicinally under the name croton chloral hydrate.

810. *In what form does oleic acid exist in nature?*

In combination with glycerol it forms the greater part of all the oils, animal and vegetable.

811. *What are its properties?*

A colorless or slightly yellow, oily fluid, neutral in reaction when pure. Upon exposure to air it becomes yellow, rancid, and acid. At 14° ($57^\circ.2$ F.) it solidifies to a crystalline mass. Almost insoluble in water, soluble in alcohol and ether.

812. *In what officinal preparation is allyl thiocyanate contained, and what are the properties of that substance?*

In the essential oil of mustard = *Oleum sinapis volatile*, U. S. The thiocyanate, to which the rubefacient and vesicant actions of mustard are due, is produced by the action of a nitrogenized substance, called *myrosin*, upon *potassium myronate*, contained in the mustard, in the presence of H_2O at a moderate temperature. Myrosin is coagulated and rendered inert by a tem-

perature of 40° (104° F.), or by contact with acetic acid.

(For other ALLYLIC COMPOUNDS see Manual, pp. 301-307.)

HYDROCARBONS. C_nH_{2n} .

813. Which is the most important member of the second series of hydrocarbons?

Ethylene, C_2H_4 ; also known as olefiant gas, elayl, or heavy carburetted hydrogen.

814. Of what industrial product is it the most important constituent?

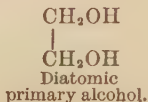
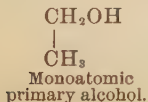
Illuminating gas.

814a. State its properties.

It is a colorless gas, having a peculiar, disagreeable odor; it burns with a luminous flame, and forms explosive mixtures with air and oxygen. It is irrespirable. Equal volumes of this gas and chlorine unite directly to form an oily liquid having the composition $C_2H_4Cl_2$, known as "Dutch liquid."

814b. What series of alcohols correspond to these hydrocarbons? Explain their constitution.

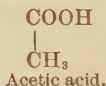
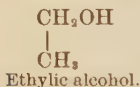
The glycols. The primary alcohols of the ethylic series are monoatomic (see Q. 716, 717), and contain a single group CH_2OH . The glycols are diatomic and contain two such groups:



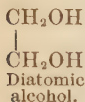
ACIDS $C_nH_{2n}O_3$ AND $C_nH_{2n-2}O_4$.

815. *Explain the relations between the primary glycols and the acids derived from them by oxidation.*

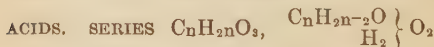
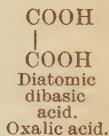
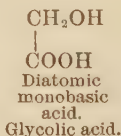
The primary monoatomic alcohols, containing a single group CH_2OH (see Q. 716, 717, 745), yield by oxidation each a single acid :



The glycols, containing two groups CH_2OH , produce two series of acids by oxidation, each of which is diatomic, as the alcohol is diatomic, but one is monobasic, containing a single group $COOH$, while the other is dibasic, containing two such groups :



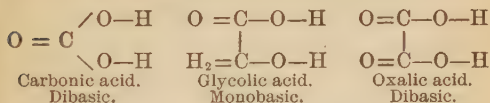
Glycol.



816. *How does the first term of this series differ from the remainder in basicity?*

The first acid of the series is dibasic, while the

remainder are monobasic. The graphic formulæ indicate the cause of this difference :



817. *Does carbonic acid exist free in nature?*

It does not ; the substance usually designated by this name is the corresponding anhydrid.

818. *What compounds of carbon and oxygen exist free?*

Carbon monoxid CO = Carbonic oxid.

“ dioxid CO_2 = “ anhydrid.

819. *Under what conditions is carbon monoxid formed?*

When coal is burnt with an insufficient supply of air; in open charcoal fires; by passing CO_2 or steam over red-hot coal; by heating oxalic acid with H_2SO_4 .

820. *Describe the prominent properties of CO.*

It is a colorless, odorless, tasteless gas, lighter than air, very sparingly soluble in H_2O . It unites readily with O to form CO_2 , burns in air with a blue flame, and reduces metallic oxids at high temperatures.

821. *What is the action of CO on the animal economy?*

It is actively poisonous. It causes death by forming a compound with hæmoglobin which is more stable than the oxygen compound, and whose formation consequently interferes with

the oxygen-carrying function of the blood pigment.

822. *What industrial gases contain CO?*

The gases discharged from blast furnaces and from copper furnaces (13 to 32%); the gases emanating from charcoal fires; the gases produced during the combustion of anthracite coal with deficient draught; coal gas (4 to 7.5%); "water-gas" (30 to 35%).

823. *What treatment should be followed in asphyxia by CO, and what is the prognosis?*

Stimulants and plenty of fresh air may prevent cessation of respiration, but it is questionable whether they or artificial respiration are of much value after the breathing has stopped. The prognosis is very unfavorable.

824. *What is the appearance of the blood after death from CO?*

It is persistently bright-red in color. When examined spectroscopically, it shows two absorption bands of equal intensity, and nearer to the violet end of the spectrum than those of oxy-hæmoglobin. A solution of NaHO (sp. gr. 1.3) added to normal blood produces a black precipitate, which is greenish-brown in thin layers. With carbon monoxid blood, the same reagent forms a bright-red clot.

825. *Under what names is CO₂ known?*

Carbon dioxid, carbonic anhydrid, and, improperly, carbonic acid.

826. *How is CO₂ produced?*

By the combustion or complete oxidation of carbon or of any substance containing carbon; by the decomposition of a carbonate by a stronger

acid; by the respiration of animals; by fermentation. Carbon dioxid is also discharged into the atmosphere by volcanoes, or fissures in the earth in volcanic regions; from mineral springs; from lime kilns, cement works, etc.; and from mines by explosions of fire-damp.

827. *Give the principal physical properties of CO_2 .*

Under ordinary conditions of pressure and temperature, a colorless, odorless gas, having a faint acid taste; under the influence of increased pressure and diminished temperature, it forms a liquid which is very volatile, and which solidifies at -90° (-130° F.). Gaseous CO_2 will neither burn nor support combustion. It is soluble in water, the quantity dissolved increasing with the pressure.

828. *In what proportion does CO_2 exist in air?*

About 4 in 10,000.

(See Manual, pp. 319-326.)

829. *Why does it not accumulate in the air?*

Because it is absorbed by plants under the influence of sunlight, and is by them decomposed, the carbon entering into the various organic substances produced by the plant.

830. *What action has pure CO_2 when inhaled?*

It produces spasm of the glottis and almost immediate death.

831. *In what two ways may the proportion of CO_2 in air be increased?*

1. By the addition of CO_2 to normal air, as in the processes of fermentation and lime burning.
2. By the oxidation in air of a substance containing carbon, as in the processes of combustion and respiration.

832. *Which of these most rapidly renders air unfit for respiration, and why?*

The second ; because not only is the deleterious gas increased, but it is formed at the expense of the oxygen, which is correspondingly diminished.

833. *How does air coming from the lungs differ from inspired air?*

The proportion of O is diminished, while that of CO₂ and H₂O is increased.

834. *What proportion of CO₂ is contained in expired air?*

About 4 per cent. in volume.

835. *What proportion of oxygen is absorbed from the air in passing through the lungs?*

About 5 per cent. in volume.

836. *How do candles and gas lights compare with human beings in the quantity of oxygen which they consume, and of carbon dioxid which they produce?*

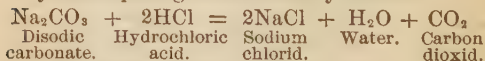
A candle about equals an adult man in the quantity of O consumed, and of CO₂ produced in its combustion. An ordinary gas-burner is equal to ten adults.

837. *What is "soda water"?*

Water holding in solution a large quantity of CO₂ under pressure. The gas escapes in bubbles when the pressure is removed.

838. *How is carbon dioxid obtained?*

By decomposing a carbonate by an acid :



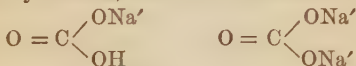
839. *By what tests is it recognized?*

By the formation of a white precipitate when

it is bubbled through lime water. By being absorbed when confined over a solution of potassium hydroxid.

840. *Explain the constitution of the carbonates.*

Although free carbonic acid, $\begin{matrix} (\text{CO})'' \\ \text{H}_2 \end{matrix} \left\{ \text{O}_2 \right.$, does not exist, the corresponding salts are widely diffused in nature. As the acid is dibasic, the univalent metals form with it two series of salts, in one of which only one atom of hydrogen is replaced by a metal, and in the other both :



With bivalent metals, two salts also exist, each containing a single atom of the metal, in the one case substituted in a single molecule of the acid, in the other in a double molecule.

841. *What compound of carbon and sulfur resembles carbon dioxid in its constitution?*

Carbon disulfid, CS_2 , or thiocarbonic anhydrid.

842. *What are its properties?*

Clear, colorless liquid, refracting light strongly, having a disagreeable, penetrating odor and sharp taste; heavier than H_2O , with which it does not mix; volatile at ordinary temperatures, boils at 42° ($107^\circ.6$ F.); has not been solidified; burns readily, forms an explosive mixture with air; good solvent for fats, resins, and india-rubber.

843. *How is ordinary "lactic acid" formed, and under what other names is it known?*

By a peculiar fermentation, known as the lac-

tic, of sugars, in sour milk, and in a variety of other fermented products, as in sauerkraut and some kinds of pickles. It also exists in the stomach during digestion of vegetable food, but is not a constituent of the gastric secretion. It is also called lactic acid of fermentation: *Acidum lacticum*, U. S.

844. *State its characters.*

It is a clear, syrupy liquid, having a slight, not unpleasant odor and a sour taste; it is heavier than H_2O , with which it mixes in all proportions, as well as with C_2H_6O and $C_4H_{10}O$. It is a strong monobasic acid, although it contains two extraradical atoms of hydrogen.

845. *Where does sarcolactic acid occur?*

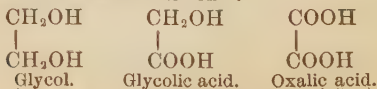
In the juices of muscular tissue, bile, and in the urine of phosphorus poisoning.

ACIDS. SERIES $C_nH_{2n-2}O_4$.



846. *State the basicity of the acids of the series $C_nH_{2n-2}O_4$, and explain their relation to the series $C_nH_{2n}O_3$ and to the glycols.*

They are dibasic. They are the products of oxidation of the glycols, more complete than in the case of the series $C_nH_{2n}O_3$:



847. *What is the composition of oxalic acid, and how does it occur in nature?*

$$\left. \begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array} \right\} = \text{C}_2\text{O}_4\text{H}_2. \text{ It exists, in combination with K, Na, and Ca, in many vegetables, to which it gives a sour taste: sorrel, pie-plant, etc.}$$

848. *How is it prepared industrially?*

By the oxidation of starch, sugar, wood, or other organic matter, by KHO, or by HNO₃.

849. *Describe its properties.*

Crystallizes in colorless, odorless prisms, with 2Aq; has a sour taste; soluble in 8 parts cold, and much more soluble in hot water, as well as in alcohol and ether. It is a strong dibasic acid; its solutions have a strong acid reaction and act as corrosives upon animal tissues. Poisonous.

850. *In mistake for what substance is oxalic acid sometimes taken?*

Epsom salt.

851. *Describe the symptoms of oxalic acid poisoning.*

They vary much in character, according to the amount and degree of concentration of the dose. With large doses in concentrated solution, the corrosive action of the acid is the more prominent; with smaller amounts its truly poisonous effects are more apparent.

The sour taste of the acid is rapidly followed by a burning pain, increasing in intensity, in the mouth, throat, and stomach; and persistent vomiting of a dark, "coffee-ground" material. The pulse becomes small and imperceptible, and

the patient dies in collapse, preceded frequently by convulsions, within half an hour.

If the case be prolonged, swallowing becomes very difficult and painful; there are numbness and tingling of the skin; twitchings of the facial muscles; convulsions, frequently tetanic; delirium; and lumbar pain.

Death occurs in some cases within three to ten minutes, sometimes almost immediately, and in some cases it is delayed for several days.

852. *What treatment should be followed in cases of oxalic acid poisoning?*

Magnesia (magnesia usta), or slaked lime suspended in a small quantity of water, or mucilaginous liquid, should be given *as soon as possible*. If vomiting do not occur, and if the symptoms of corrosion be not marked, an emetic. The stomach pump should *not* be used, nor should the alkaline carbonates be depended upon as antidotes.

853. *What action has oxalic acid upon cloth and writing ink?*

It forms a brown stain upon cloth, and bleaches writing ink. Writing removed by oxalic acid may be restored in blue by moistening with solution of potassium ferrocyanid.

854. *Give tests for oxalic acid and the soluble oxalates.*

Calcium chlorid added to the solution, neutralized with NH_4HO , forms a white, crystalline precipitate, which is insoluble in acetic acid, but soluble in HCl . The same precipitate is formed with lime water, or solution of calcium sulfate. Silver nitrate, in neutral solution, forms a white

precipitate, which is easily soluble in HNO_3 . This precipitate does not darken when the fluid is boiled, but when dried and heated it explodes.

855. *Explain the constitution of the oxalates.*

Oxalic acid being dibasic, $\begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array}$, forms with the univalent metals two series of salts, $\begin{array}{c} \text{COOM}' \\ | \\ \text{COOH} \end{array}$ and $\begin{array}{c} \text{COOM}' \\ | \\ \text{COOM}' \end{array}$, and with the bivalent metals a single series, $\begin{array}{c} \text{COO} \\ | \\ \text{COO} \end{array} \rangle \text{R}''$.

(For other ACIDS, COMPOUND ETHERS, ALDEHYDES, and ANHYDRIDS of this series, see Manual, pp. 329-332.)

DIAMINS AND TRIAMINS.

856. *Explain the constitution of the diamins and triamins.*

As the monamins (see Q. 769) are produced by the substitution of univalent hydrocarbon radicals in a single molecule of ammonia, so the diamins are formed by the substitution of bivalent hydrocarbon radicals in two molecules of ammonia, *e.g.*, methylenediamin, $\text{H}_2\text{N}-\text{CH}_2-\text{NH}_2$; and the triamins by the substitution of trivalent radicals in three molecules. Like the monamins, they are capable of forming salts and hydroxids corresponding to those of ammonium,

857. *What is a ptomaïn ?*

An alkaloid (see Q. 1023) produced during the putrefaction of animal substances.

858. *What ptomaïns are known to be diamins ?*

Putrescin=tetramethyldiamin, $\text{H}_2\text{N}-(\text{CH}_2)_4-\text{NH}_2$; and Cadaverin=pentamethyldiamin, $\text{H}_2\text{N}-(\text{CH}_2)_5-\text{NH}_2$. Trimethyldiamin and Hexamethyldiamin are also ptomaïns. Neuridin, $\text{C}_5\text{H}_{14}\text{N}_2$, and Saprins, $\text{C}_5\text{H}_{16}\text{N}_2$, are also diamins of undetermined constitution.

859. *Describe the prominent properties of putrescin and cadaverin.*

The free bases are syrupy, colorless liquids, the former having a seminal odor, and the latter a strong, disagreeable odor resembling that of coniïn. They absorb CO_2 from the air, and form crystalline salts with acids. They are produced during the later stages of putrefaction, and are not actively poisonous.

860. *What is a leucomaïn ?*

An alkaloidal or basic substance normally produced in the animal body during life, or obtained from it.

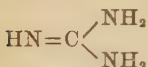
861. *What leucomaïns are known to be triamins or derivatives of triamins ?*

Guanidin; Methylguanidin; Creatin; Creatinin; several other bodies closely related to creatinin.

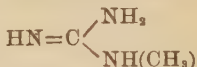
862. *Describe the constitution and relations of guanidin and methylguanidin.*

Guanidin, first obtained from the oxidation of guanin, is carbotriamin (formula I. below). Methylguanidin (formula II. below) is formed by the oxidation of creatin and creatinin, which

are closely related in constitution, and is also a product of putrefaction. Both are crystalline solids which combine with acids to form salts:



I. Guanidin.



II. Methylguanidin.

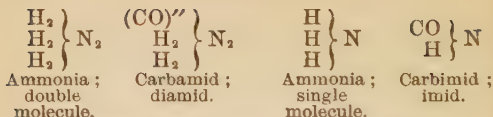
863. *Describe the occurrence and properties of creatin and creatinin.*

Creatin exists in muscular tissue. It is a crystalline solid, soluble in boiling H_2O and in alcohol, which is readily converted into creatinin, which differs from it by H_2O less. Creatinin is a constant constituent of the urine, being eliminated in the daily quantity of 0.6 to 1.3 gram (9.25 to 20 grains). It is a crystalline solid, soluble in water, a strong base, alkaline in reaction, and forms a very sparingly soluble, crystalline, double salt with zinc chlorid.

DIAMIDS. IMIDS. CARBAMIC ACIDS.

864. *Explain the constitution of the diamids and of the imids.*

The diamids are substances derived from a double molecule of ammonia by the substitution of one or more bivalent oxidized radicals for one or more pairs of hydrogen atoms. The imids are derived from a single molecule of ammonia by the substitution of a bivalent, oxidized radical for two of its hydrogen atoms;



865. *Under what names is the amid of carbonic acid known, and what is its constitution?*

Carbamid, Urea. $\text{H}_2\text{N}-\text{CO}-\text{NH}_2$.

866. *Give the principal physical properties of urea.*

Crystallizes in transparent needles or four-sided prisms, without Aq; permanent in air; odorless, having a cooling, slightly bitter taste, resembling that of saltpetre. Soluble in an equal weight of cold water, very soluble in boiling water and in five parts of cold or one part of hot alcohol, the solutions being neutral in reaction. At 120° (248° F.) it melts, and slightly above that temperature is decomposed.

867. *In what animal fluids is urea found?*

In the blood, lymph, humors of the eye, perspiration, and especially in the urine.

868. *What is the source of urea in the economy?*

It is the principal product of the oxidation of albuminoid substances in the animal body, and is the form in which most of the nitrogen is excreted.

869. *How may urea be obtained synthetically?*

By heating its isomere, ammonium isocyanate. (See Q. 804.)

870. *What occurs when an aqueous solution of urea is long heated?*

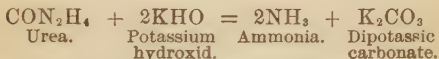
Urea takes up the elements of two molecules

of water, and is converted into ammonic carbonate :

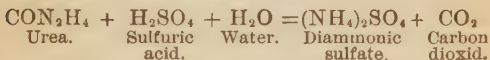


871. *Under what other conditions does this change occur?*

Under the influence of certain ferments, and of decomposing animal matter. When urea is heated with a base or with an acid. When a base is used, ammonia is liberated and a carbonate formed :

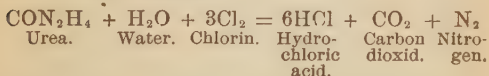


When an acid is used, carbon dioxid is given off and an ammoniacal salt remains :

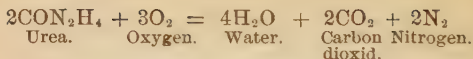


872. *What effect have chlorin, bromin, and nitrous acid upon urea?*

Chlorin and bromin, and the hypochlorites and hypobromites, decompose urea, with formation of hydrochloric or hydrobromic acid, carbon dioxid, and nitrogen :



Nitrous acid (or nitric acid charged with the oxids of nitrogen) produces an oxidation of urea :



873. *What occurs when pure nitric or oxalic acid is added to a cold concentrated solution of urea?*

The nitrate or oxalate of urea is formed, and, as these are much less soluble than urea, they separate as crystals.

874. *What quantity of urea is discharged by a normal adult in 24 hours?*

From 25 to 35 grams (about 1 to $1\frac{1}{2}$ 3).

875. *How does the elimination of urea vary with age and sex?*

Taking the quantity excreted in 24 hours by an average adult man at 0.5 grm. for each kilogram of body weight, it is found that in children the elimination is much greater. A child of 6 years discharges in 24 hours 1 grm. urea for each kilo. of body weight. In old persons the elimination of urea diminishes. Females discharge less urea than males, except during pregnancy, when the elimination is much increased.

876. *How does the diet affect the elimination of urea?*

The more highly nitrogenized the diet, the greater the elimination of urea.

877. *Give a clinical method for determining whether the elimination of urea is excessive or deficient.*

Take from the fresh, mixed urine of 24 hours two samples, one of 5 c.c. and the other of double that quantity, and place them in watch glasses. To the smaller sample add about one-third of its

volume of pure *colorless* HNO_3 ; if crystals appear in this immediately or within a few moments, the amount of urea is above the normal. Evaporate the other sample to one-half its bulk at a low temperature [over a water-bath, or on the corner of a stove, where the temperature does not exceed 90° (194° F.)], allow it to cool, and add HNO_3 as before ; if crystals do not form within a few moments, the proportion of urea is below the normal.

The quantity of urine passed in 24 hours must be taken into consideration ; thus, if, instead of the normal quantity of 1,200 c.c., the patient only pass 600 c.c., the first sample should be diluted with its own volume of H_2O , and the second used without evaporation ; if, on the other hand, the urine be that of a diabetic patient passing 3,600 c.c. per diem, 15 c.c. of the urine reduced to 5 by evaporation should be used for the first test, and 30 c.c. reduced to 5 for the second.

(For a more accurate method, see Manual, pp. 343-345.)

878. *To what pathological causes may diminution or increase of elimination of urea be due ?*

A diminution may be due to some condition interfering with the normal transformation of albuminous substances in the body, as in certain chronic diseases. More frequently, however, a diminished proportion of urea in the urine is not due to a diminution in the production, but to the fact that the urea formed has not been separated by the kidneys, as in uræmia, and in diseases attended with dropsical effusions. An excess of

urea occurs in fevers and in true diabetes, in which it indicates the amount of waste of tissue, and is, therefore, a grave symptom.

COMPOUND UREAS.

879. *What are compound ureas?*

Substances derived from urea by the substitution of radicals for the remaining atoms of hydrogen. Those containing oxidized (or acid) radicals are called *ureids*. If derived from a single molecule they are *monureids*; if from two molecules of urea, *diureids*.

880. *Give the formula of uric acid.*

$C_5H_4N_4O_9$. Its constitution has been recently established, and shows it to be the diureid of tartronic acid.

881. *In what parts of the body does it occur?*

In the urine of the carnivora and in the excrements of birds, reptiles, and insects; in the blood, spleen, lungs, liver, pancreas, and brain. It enters into the composition of many urinary calculi, and the so-called "chalk stones" deposited in the joints in gout.

882. *In what form does it exist?*

It does not occur uncombined in the normal body, but exists as the urates of sodium and ammonium, principally the former.

883. *What is the source of uric acid in the economy?*

It is a product of the oxidation of albuminous substances, and is one of the intermediate steps in the formation of urea.

884. *Give the properties of pure uric acid.*

A light, white powder, composed of small crystals; odorless, tasteless, very sparingly soluble in H_2O , insoluble in alcohol and ether, soluble without decomposition in H_2SO_4 or HCl . Moist uric acid has an acid reaction. It is a dibasic acid.

885. *Give a test for the presence of uric acid.*

Moisten with HNO_3 and evaporate nearly to dryness, cool, add NH_4HO . If uric acid be present, the HNO_3 residue is yellow or red, and on addition of the NH_4HO a brilliant red color is produced.

886. *What substance is formed in this reaction?*
Murexid.

887. *How may uric acid be obtained from urine?*

By adding HCl , and allowing the mixture to stand. The HCl unites with the base, and the uric acid thus liberated, being insoluble, is deposited.

888. *How do the crystals obtained by 887 differ from those of pure uric acid?*

In being yellow or brown. The coloring matter of the urine adheres tenaciously to uric acid, and it is very difficult to obtain the pure acid from this source. The form of the crystal also differs from that of crystals of the pure acid.

889. *What is the object of administering lithium compounds in diseases attended with excessive production of uric acid?*

Urate of lithium is more soluble than urate of sodium; therefore, if the former salt be formed in the body in place of the latter, there is less

danger of the formation of deposits. If deposits already exist, either in the tissues or as calculi, their solution and removal are aided by the formation of lithium urate.

890. *How much uric acid is normally excreted in 24 hours?*

From 0.3 to 0.8 gram (4.6 to 12.3 grains).

891. *Give a process for the quantitative determination of uric acid in urine.*

Place 200 c.c. of urine in a beaker, add 5 c.c. pure HCl; stir, cover, and set aside for 24 hours; collect the crystals formed upon a small weighed filter, wash with cold distilled water until the washings no longer precipitate with silver nitrate; dry the filter with the adhering crystals, and weigh; the difference between this weight and that of the filter gives the amount of uric acid. A slight correction is required for the sparing solubility of uric acid. If the amount of wash water used do not exceed 30 c.c., no correction is required; if it do, add to the result 0.045 milligr. for each c.c. more than 30 used.

892. *What reaction of the urine favors the deposition of uric acid gravel or calculi?*

A strongly acid reaction.

893. *Where does xanthin occur?*

In the urine and muscular tissue; as the main constituent of certain rare urinary calculi.

894. *What substance, closely related to xanthin, is found in muscular tissue?*

Hypoxanthin or sarkin.

895. *State the facts of physiological interest concerning adenin.*

It is a leucomaïn separated from extract of

pancreas, being produced along with other compound ureas by the decomposition of nuclein (see Q. 919). It is very widely distributed in the vegetable and animal kingdoms, particularly in tissues abounding in nucleated cells. It is a polymere of hydrocyanic acid, having the formula $C_5H_5N_5$. It crystallizes in plates or needles, very soluble in hot H_2O , but sparingly soluble in cold H_2O . It resists oxidizing and hydrating agents obstinately.

895a. *What vegetable alkaloids are compound ureas, and where do they occur?*

Theobromin, $C_7H_8N_4O_2$, occurs in *Theobroma cacao*; and Caffein, $C_8H_{10}N_4O_2$, also known as thein and guaranin, which exists in coffee, tea, Paraguay tea, and in other plants.

(See Manual, pp. 346-355.)

TRIATOMIC ALCOHOLS.

896. *What important triatomic alcohol is known? Explain its constitution.*

Glycerol; $C_3H_8O_3$. A monoatomic alcohol may be regarded as a molecule of water, in which one atom of hydrogen is replaced by an univalent radical: $\left. \begin{smallmatrix} (C_2H_5)' \\ H \end{smallmatrix} \right\} O$; a diatomic alcohol as a double molecule of water, in which a double atom of hydrogen has been replaced by a bivalent radical: $\left. \begin{smallmatrix} (C_2H_4)'' \\ H_2 \end{smallmatrix} \right\} O$; and a triatomic alcohol as a triple molecule of water, in which a

triple atom of hydrogen has been replaced by a trivalent radical : $(\text{C}_3\text{H}_5)''' \left. \begin{matrix} \\ \text{H}_3 \end{matrix} \right\} \text{O}_3 = \text{glycerol}.$

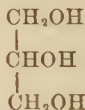
The intimate structure of the molecules is shown by the graphic formulæ :



Ethylie alcohol.
Monoatomic.



Glycol.
Diatomic.



Glycerol.
Triatomic.

897. *What does the termination ol indicate?*

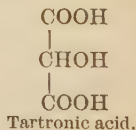
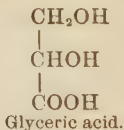
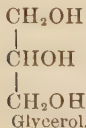
That the substance is an alcohol or a phenol.

(See Q. 715, 978.)

898. *Give the physical characters of glycerol.*

A colorless, odorless, syrupy liquid; neutral in reaction; miscible in all proportions with water; having a sweetish taste; not altered by exposure to air.

899. *Write the graphic formula of glycerol and those of the acids obtainable from it by oxidation.*



900. *Where does malic acid occur in nature?*

It occurs, either free or in combination with K,

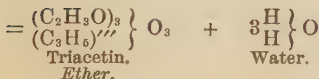
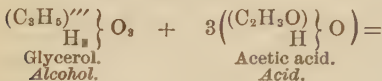
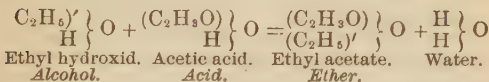
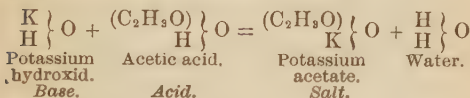
Na, Ca, or Mg, in many fruits, such as apples, cherries, the berries of the mountain ash, etc.

901. *Into what salts are the malates, citrates, and tartrates converted in the economy, and with what influence upon the urine?*

They are oxidized, with formation of the corresponding carbonates. As these salts are alkaline in reaction, they diminish the acidity of the urine or render it alkaline.

902. *What are the glycerids?*

They are compound ethers produced by the action between glycerol and the acids. As glycerol is triatomic, it behaves like the hydroxid of a trivalent metal and consequently forms three ethers with the monobasic acids:



Similarly we have *diacetin*, $(C_2H_3O_2)_2(C_3H_5)HO$, and *monacetin*, $(C_2H_3O_2)(C_3H_5)(HO)_2$.

903. *What important vegetable and animal substances consist of glycerids?*

The fixed oils and fats.

904. *What is the chemical difference between the fixed and volatile oils?*

The fixed oils are glycerids, constituted as already described and capable of saponification. The volatile oils are for the most part hydrocarbons, and are not subject to the same decompositions as the glycerids.

905. *What are the principal glycerids occurring in the fixed oils and fats?*

Tristearin, tripalmitin, and triolein.

906. *How do these three differ in their physical properties?*

Tristearin and tripalmitin are solid at the ordinary temperature, the former fusing at 68° ($154^\circ.4$ F.), the latter at 50° (122° F.). Triolein is liquid at the ordinary temperature and only solidifies at 0° (32° F.).

907. *To what conditions is the difference in consistence of the fixed oils and fats due?*

Partly to the temperature, all fats becoming liquid when heated, and the oils solidify when cooled sufficiently. At a given temperature the consistence depends upon the relative proportions of triolein on the one hand, and tripalmitin and tristearin on the other.

908. *What glycerid of a mineral acid is used in the arts, and for what purpose?*

Trinitroglycerol. As an explosive, either

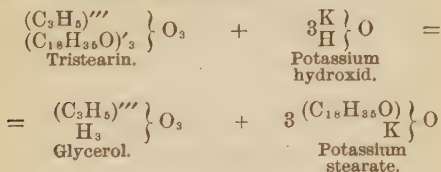
alone or mixed with some inert substance, as in dynamite, giant powder, etc.

909. *What is an emulsion?*

A liquid fat in a state of fine and permanent subdivision and suspension in a watery fluid. Oil and water will not mix under ordinary conditions; but if small quantities of certain other substances, such as albumen, be added, and the two liquids shaken together, an emulsion is formed.

910. *Explain the process of saponification?*

It is a double decomposition between a fat and an alkali, in which the metallic salt of the acid and glycerol are formed:



911. *What is the source of the fats in the body?*

They are, to a great extent, taken with the food in their own form, but are also formed in the body from starchy and saccharine substances, and even from albuminous substances. Animals may be fattened on food which contains little fat but is rich in starch.

912. *What changes do fats undergo in the economy?*

They are oxidized, and their component ele-

ments are finally discharged as CO_2 and H_2O . This oxidation in the body is attended by the liberation of force and heat; a fatty diet is, therefore, eminently suited to cold climates, as it maintains the body temperature in two ways: 1st, by the liberation of heat in its oxidation; and 2d, by preventing the loss of heat, the layer of fat between the skin and the tissues acting as a non-conductor.

913. *State the prominent physical properties of fats.*

They are lighter than water, with which they do not mix. When liquid fats are shaken with water they form globules of varying size, circular in outline, and refract light strongly. They are soluble in ether, to a certain extent in alcohol, and in solutions of the alkalies with formation of soaps. They produce a translucent stain on paper.

914. *What is a soap, and what is the chemical difference between hard and soft soap?*

A mixture of the stearate, palmitate, and oleate of Na or K, the oleate predominating greatly. The Na compounds form the hard soaps, and the K compounds soft soap.

915. *In what respect does butter fat differ from other fats and oils?*

In containing a notable proportion (5 to 8 per cent.) of the glycerids of butyric acid and its near homologues. These acids themselves differ from stearic, palmitic, and oleic acid in being soluble in water, and capable of being distilled, while the higher acids are insoluble, and are decomposed when heated.

916. *In what situations in the body do the lecithins and protagon occur?*

In nerve and brain tissue, particularly the gray substance, blood corpuscles, blood serum, milk, bile, and seminal fluid.

917. *What substances are derived from lecithin by decomposition by a base?*

Glycerophosphoric acid, stearic acid, and cholin.

918. *What substance other than lecithin is produced from the decomposition of protagon?*

A body containing N but not P, called cerebrin.

919. *What is a nuclein?*

A phosphorized substance existing in the nuclei of animal and vegetable cells. Nucleins from pus, spermatic fluid, brain, and yeast have been investigated. They are white, amorphous, rather soluble in H_2O , insoluble in acids and in the gastric juice. They are extremely unstable, and on decomposition yield phosphoric acid, an albuminoid substance, xanthin, hypoxanthin, guanin, and adenin.

THIRD SERIES OF HYDROCARBONS.

SERIES C_nH_{2n-2} .

920. *Give the formula, occurrence, and properties of acetylene.*

Its formula is C_2H_2 or $HC\equiv CH$. It is one of the most important constituents of coal gas, and is produced by the action of heat upon many organic substances. It is a colorless, inflammable gas, having a disagreeable odor; forms an explosive mixture with air; detonates on contact with Cl in daylight, and combines directly with N under the influence of electric discharges to form hydrocyanic acid.

TARTARIC ACID.

921. *What is the constitution and basicity of tartaric acid?*



$= C_4H_6O_6$. It is dibasic, only the

two hydrogen atoms contained in the groups COOH being replaceable.

922. *State the properties of tartaric acid.*

Crystallizes in large, hard, transparent prisms ; odorless ; having a sour but not disagreeable taste. Very soluble in water ; soluble in alcohol. The aqueous solution becomes mouldy on standing.

923. *Give the composition of seidlitz powders, and explain the reaction which occurs when their solutions are mixed.*

The powder in the blue paper is a mixture of Rochelle salt (q. v.) and hydro-sodic carbonate ; the white paper contains tartaric acid. When the solutions are mixed, the carbonate is decomposed by the acid ; sodic tartrate remains in the solution, while the liberated CO_2 produces the effervescence.

924. *Give an account of the source of tartaric acid and the tartrates.*

The tartrates exist in the juice of the grape in notable quantities, and are obtained industrially as a by-product in the manufacture of wine. During the fermentation of wine, the must becomes more and more alcoholic, and the hydro-potassic tartrate which it contains, being less soluble in alcoholic fluids than in water, is gradually deposited, forming the crude tartar, or "argol," of commerce.

925. *What are the chemical name and characters of cream of tartar ?*

Hydro-potassic tartrate, obtained by purifying crude tartar. A white, crystalline powder, odorless, having a sourish taste ; soluble in 480 parts of cold and in 20 parts of hot water ; insoluble in alcohol.

926. *How is Potassæ tartras, U. S. P., formed, and what is its chemical name?*

By adding hydro-potassic tartrate to solution of potassic carbonate, when CO_2 is liberated and potassic tartrate, $\text{C}_4\text{H}_4\text{O}_6\text{K}_2$, is formed.

927. *In what important physical character does it differ from hydro-potassic tartrate, and how?*

It is very soluble in water, while the hydro-salt is only sparingly soluble. It has hence received the common name of soluble tartar.

928. *What is the composition of Rochelle salt?*

It is double tartrate of potassium and sodium: $\text{COONa} - (\text{CHOH})_2 - \text{COOK} = \text{C}_4\text{O}_6\text{H}_4\text{NaK}$.

929. *What is the composition of tartar emetic?*

It is a double tartrate of potassium and the radical $(\text{SbO})'$: $\text{COOK} - (\text{CHOH})_2 - \text{COO}(\text{SbO}) = \text{C}_4\text{O}_6\text{H}_4\text{K}(\text{SbO})$, or antimonyl-potassic tartrate.

930. *State its properties.*

It forms shining, colorless, transparent prisms with 1Aq, or a white powder; odorless; having a sweetish, unpleasant, metallic taste; soluble in 15 parts cold or 2 parts hot water.

931. *Whence is citric acid obtained, and what are its characters?*

From lemon juice. It forms large, colorless crystals, with 1Aq, having a strong acid taste; very soluble in water, the solution becoming mouldy by keeping. It is a tribasic acid.

CARBOHYDRATES.

932. *What are the characters of substances of this class?*

Substances of unknown constitution, composed

of C, H, and O, the last two being in the proportion to form water, *i.e.*, H_2 to O. But few of them have been obtained artificially, and nearly all exist in vegetable and animal bodies.

NOTE.—Although the constitution of these substances is still uncertain, except that of glucose, whose synthesis has been accomplished, their reactions show that some are alcohols, others aldehydes, and others, like glucose, of mixed function.

933. *Into what three groups may they be divided?*

1. Glucose group. 2. Cane-sugar group. 3. Starch group.

934. *Name the most important member of the first group, and give its synonyms.*

Glucose. Grape sugar; liver sugar; diabetic sugar; dextrose.

935. *State its chief physical properties.*

Forms yellowish nodules or crystals; very soluble in water and in alcohol; has a sweet taste, less marked than that of cane sugar.

936. *How may it be obtained artificially?*

From cane sugar or starch; either (1) by boiling with a dilute mineral acid; or (2) by the action of a vegetable ferment, called diastase, which is formed during the germination of grain.

937. *Is sugar a normal or abnormal constituent of human urine?*

It exists normally in quantities too small to be distinguished by the ordinary tests. Its presence is pathological only when the quantity is so increased that it may be detected by the methods generally used, the gravity of the disorder

being proportionate to the quantity of sugar eliminated.

938. *What precaution is to be observed before testing for sugar?*

The urine should first be tested for albumin. If this be present, it should be removed by heating the urine to near the boiling point, and filtering from the coagulum.

939. *Describe Fehling's test.*

Place in a test tube about 1 c.c. Fehling's solution (see Manual, p. 380), and boil; no reddish tinge should be observable, even after five minutes' repose. Add the liquid under examination gradually, and boil after each addition. In the presence of sugar a yellow or red precipitate is formed. In the presence of *traces* of glucose, only a small amount of precipitate is produced, which adheres to the glass, and is best seen when the blue liquid is poured out.

940. *Describe Trommer's test.*

To the urine, in a test tube, add one or two drops of a solution of cupric sulfate, and then about half as much Liq. potassæ as there was urine; shake and boil. If sugar be present, a yellow or red precipitate of cuprous oxid is formed. In applying Fehling's or Trommer's test to urine, a dirty yellowish-green color is frequently observed; this is *not* due to the presence of sugar.

941. *Explain the principles upon which Trommer's and Fehling's tests are based.*

By the action of the boiling alkali, glucose is converted into substances (glucic and melassic acids) which are very prone to oxidation, and are

consequently good reducing agents; if cupric sulfate be present, it is converted into cuprous sulfate, and this in turn decomposed with deposition of cuprous oxid. As there is deoxidation of the copper compound, these tests are spoken of as "reduction tests."

942. *Describe Boettger's test.*

Render the liquid strongly alkaline by addition of Na_2CO_3 . Divide about 6 c.c. of the alkaline liquid in two test tubes. To one test tube add a very minute quantity of powdered subnitrate of bismuth, to the other as much powdered litharge. Boil the contents of both tubes. The presence of glucose is indicated by a dark or black color of the bismuth powder, the litharge retaining its natural color.

943. *How is the fermentation test conducted?*

Take three test tubes, A, B, and C, place in each some washed yeast; fill A completely with the urine to be tested, and place it in an inverted position, the mouth below the surface of some of the same urine in a flat vessel (the entrance of air being prevented, during the inversion, by closing the opening of the tube with the finger until it has been brought below the surface of the urine). Fill B completely with some urine to which glucose has been added, and C with distilled water, and invert them in the same way as A; B in saccharine urine, and C in distilled water. Leave all three tubes in a place where the temperature is about 25° (77° F.), for twelve hours, and then examine them. If gas have collected in B over the surface of the liquid, and none in A, the urine is free from sugar. If gas have collected in both

A and B, and not in C, the urine contains sugar. If no gas have collected in B, the yeast is worthless, and if any gas be found in C the yeast itself contains CO_2 . In the last two cases the process must be repeated with a new sample of yeast.

944. *Describe Robert's method for determining the quantity of sugar in urine.*

The specific gravity of the urine is carefully observed at 25° (77° F.); yeast is then added and the urine maintained at 25° (77° F.) until fermentation has stopped; the sp. gr. is again observed, when it will be found lower than before. Each degree of diminution of sp. gr. represents 0.2196 grm. of sugar in each 100 c c. of urine.

(For more accurate methods, see Manual, pp. 379-381.)

945. *Under what normal conditions may the urine contain glucose in quantity sufficient to respond to the tests?*

1. In the urine of women during pregnancy and lactation. 2. In the urine of old persons. 3. With a diet rich in starch or sugars.

946. *Under what pathological conditions may the urine contain sugar in considerable quantity?*

1. In abnormally stout persons. 2. In diseases attended with interference of the respiratory function. 3. In diseases attended with interference of the hepatic circulation. 4. In many cerebral and cerebro-spinal diseases. 5. In intermittent and typhus fevers. 6. As a result of the action of carbon monoxid, arsenic, and the anæsthetics. 7. In diabetes mellitus.

947. *What are the characters of urine in diabetes mellitus?*

It is excessive in quantity, pale in color, of

high specific gravity, and contains sugar, sometimes as much as 20 to 40 ounces being voided daily.

(See Manual, pp. 375-377.)

948. *Give the formulæ of grape and cane sugars.*

Grape sugar, $C_6H_{12}O_6$; cane sugar, $C_{12}H_{22}O_{11}$.

949. *What are the main points of difference between grape and cane sugars?*

Cane sugar is more easily and perfectly crystallizable, more soluble, and sweeter than glucose. It also differs from glucose in not being directly capable of fermentation, and in not reacting with the reduction tests for sugar.

950. *Describe the action of heat on cane sugar.*

When heated to 160° (320° F.) it melts, and, on cooling, forms an amber-colored solid known as "barley sugar." If the heat be continued to 210° (410° F.), a brown, tasteless mass, known as "burnt sugar" or "caramel," remains. This is tasteless, soluble in water or dilute alcohol, and is largely used to give color to confectionery and spirits.

951. *Where is milk sugar found? Describe its characters.*

In milk. Crystallizes in hard, white prisms. It is the least soluble of all sugars in water, and is insoluble in alcohol. It enters into alcoholic fermentation with difficulty. In presence of decomposing albuminous matter, and under certain other influences, it undergoes a peculiar fermentation, known as the lactic, resulting in the formation of carbon dioxid, alcohol, and lactic acid. It reacts readily with the reduction tests.

952. *Where does starch exist in nature?*

In all plants. The main sources from which it is obtained are potatoes and cereals. It does not exist in animal tissues or fluids.

953. *Give its physical characters.*

It forms a white, shining powder, or, if dried in bulk, columnar masses. When examined microscopically it is found to consist of round or egg-shaped granules, differing in size and appearance with the source from which it was obtained. When heated, the granules swell and split into concentric layers. Almost insoluble in water, but, if soaked or boiled in water, the granules swell, burst, and finally form a gelatinous mass known as "hydrated starch," or starch paste.

954. *Describe the action of mineral acids on starch.*

When boiled with dilute mineral acids, starch is converted into glucose. Hot, concentrated nitric acid converts it into oxalic acid. Cold, fuming nitric acid dissolves it, forming an explosive nitro-compound.

955. *Give a test for starch.*

Solution of iodine with starch gives a dark violet-blue color, which disappears on warming, and returns on cooling. This reaction is characteristic and very delicate.

956. *What articles of food are composed entirely of starch?*

Sago, tapioca, arrowroot.

957. *What proportion of starch is contained in wheat and rice?*

Wheat contains about 70 per cent., and rice 90 per cent.

958. *What action have diastase, ptyalin, and the pancreatic juice upon starch?*

They first convert it into "soluble starch." This is subsequently decomposed into different modifications of dextrin ("erythrodextrin" and "achroödextrin") and maltose. The maltose is more or less completely converted into glucose.

959. *What action has dry heat upon starch?*

The granules are ruptured, and the starch is converted into dextrin.

960. *What action has boiling H_2O upon starch?*

The granules swell and finally burst, forming an opalescent solution of "soluble starch," which becomes gelatinous on cooling.

961. *What is cellulose?*

A substance having the same percentage composition as starch, and forming the basis of all vegetable fibre. It exists almost pure in absorbent cotton and Swedish filter paper.

962. *Give the formula of starch and cellulose.*

$C_6H_{10}O_5$, or a multiple thereof.

963. *Explain the action of nitric acid upon cellulose.*

By acids of different concentration one, two, or three times the group (NO_2) replaces one, two, or three atoms of hydrogen of cellulose, to form mono-, di-, and tri-nitro cellulose.

964. *How do these three differ, and for what purposes are they used?*

In the violence with which they explode on being ignited in a confined space, the force of the explosion increasing with the number of groups (NO_2) substituted; and in their solubility in a mixture of alcohol and ether, the dinitro-product being the most soluble. Trinitro-cellulose is

sometimes used as a substitute for gunpowder under the name gun-cotton. Dinitro-cellulose, or pyroxylin, dissolved in a mixture of alcohol and ether, forms the collodion used in photography and as a styptic.

965. *Where is glycogen found, and what are its properties?*

In the liver of all animals. It closely resembles starch in its properties; a white, odorless, tasteless, amorphous powder; swells up in cold water, forms an opalescent solution with hot water; does not react with any of the tests for glucose, into which substance it is, however, readily converted by the same agents which convert starch into glucose, as well as by some substance existing in the liver and in blood.

966. *How is commercial dextrin made, and what are its properties?*

By subjecting starch to a dry heat of 170° (347° F.); or by heating starch to 90° (194° F.) with dilute H_2SO_4 . It is a yellowish-white powder or a yellow solid, resembling gum arabic in appearance. It is soluble in H_2O , forming mucilaginous solutions; insoluble in alcohol. It is not capable of fermentation. It reduces cupropotassic solutions at 85° (185° F.). Its solutions are dextrogyrous. It is used for the same purposes as gum arabic under the name "British gum."

967. *In what respects do erythrodextrins and achroödextrins differ from each other?*

The former are colored red by iodine, the latter are not. They also differ in their rotary and reducing powers, and in that the former are much more readily converted into sugar than the latter.

CYCLIC HYDROCARBONS AND THEIR DERIVATIVES.

AROMATIC SERIES.

968. *Why is this series designated as aromatic?*

Most of the substances included in it which exist naturally have strong and aromatic odors.

969. *Of what substance are all the members of this series derivatives?*

Of benzene; C_6H_6 .

970. *Explain the constitution of benzene, and how the other aromatic substances are derived from it.*

There is a very important difference between the constitution of the aromatic substances and that of those heretofore considered. In the latter, the atoms of carbon are arranged in an open chain, the carbon atoms of which exchange between each other one, two, or three valences:



Ethyl
hydrid.



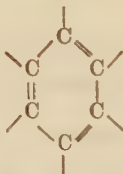
Ethylene.



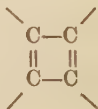
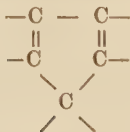
Acetylene.

In the case of benzene, however, the carbon atoms are not arranged in an open chain, but in

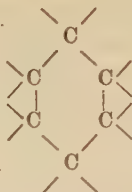
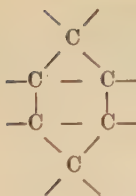
a closed one, the six C atoms alternately exchanging one and two valences:



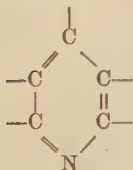
There remain six free valences. When these are all satisfied by hydrogen the resulting substance is benzene. They may, however, be satisfied by other elements, radicals, or lateral chains (see Q. 695), to produce the substances directly derived from benzene. More complex hydrocarbons and their derivatives are also produced by the union or fusion of two or more benzene nuclei, as the group C_6 , figured above, is called. Still other compounds are obtained by the elimination of one or more of the carbon atoms of the benzene nucleus to form pentagonal or quadratic nuclei, and derivatives therefrom :



Or the linkage in the benzene nucleus may be altered to increase the valence of the group, as in :



Or, further, another element may be substituted for one or more atoms of carbon in any of the above nuclei, as in :



BENZENE AND ITS DERIVATIVES.

971. *Whence is benzene obtained, and what are its uses?*

It is obtained, with other hydrocarbons closely related to it, from coal tar. Its most important use is as the starting point in the manufacture of anilin dyes. It is also used as a solvent for certain alkaloids.

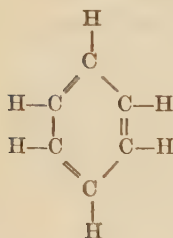
972. *Under what other names is benzene known?*
Benzol. Phenyl hydrid.

973. *State its principal properties.*

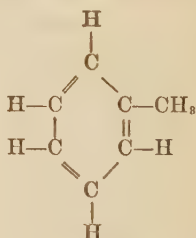
It is a colorless liquid; boils at $80^{\circ}.5$ ($176^{\circ}.9$ F.), and solidifies at $4^{\circ}.5$ ($40^{\circ}.1$ F.); does not mix with water; burns with a smoky flame. Pure benzene has an agreeable, the commercial article an unpleasant odor.

974. *How are the superior homologues of benzene derived from it?*

By the substitution of C_nH_{2n+1} for H, thus:



Benzene.



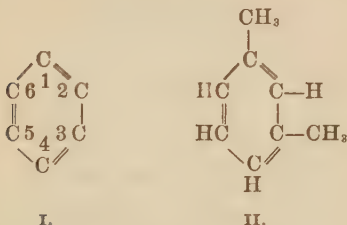
Toluene.

The group (or groups) so substituted is known as a "lateral chain," to distinguish it from the benzene nucleus.

975. *Explain what is meant by orientation.*

When a single atom or radical or lateral chain is substituted in a benzene molecule, it is immaterial in what position it is introduced; there is but one such derivative. When, however, the number of substitutions is two or more, their relative positions or "orientation" become important, because with different orientation distinct sub-

stances are formed. To distinguish these the carbon atoms are numbered, the upper being arbitrarily designated as 1, as in formula I:

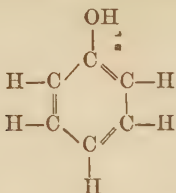


With a bisubstituted derivative there are three possible relations: 1. *Consecutive*, designated by the prefix *ortho*, in 1-2; 2-3; 3-4; 4-5; 5-6 or 6-1; 2. *Unsymmetrical*, designated by the prefix *meta*, in 1-3; 2-4; 3-5; 4-6; 5-1 or 6-2; and 3. *Symmetrical*, designated by the prefix *para*, in 1-4; 2-5; or 3-6. Thus the compound whose formula is given above II. is metadimethyl benzene. Differences in orientation also occur frequently in the more complex compounds, which will be considered later.

976. *What substance results from the substitution of a group (OH) for an atom of hydrogen in benzene?*

Phenol. Commonly known as carbolic or phenic acid.

977. Write the graphic formula of phenol.



978. Wherein do the phenols differ from the alcohols?

They do not furnish aldehydes and acids by oxidation. They are not decomposed into hydrocarbons and water by dehydrating agents. They do not react with acids to produce ethers.

979. State the properties of phenol.

It crystallizes in long, colorless needles, which fuse at 35° (95° F.). It has a peculiar odor, and a burning, bitter taste. Soluble in 20 parts of water, quite soluble in alcohol and in ether. It is a powerful antiseptic agent, coagulates albumen, and prevents fermentation.

980. Describe the analytical reactions of phenol.

1. Its peculiar odor. 2. Mix with one-quarter volume NH_4HO soln.; add two drops NaClO soln. and warm; a blue or green color, which turns red on addition of HCl to acid reaction. 3. Add two drops of liquid to a little HCl , add one drop HNO_3 ; a purple-red color. 4. Boil with HNO_3 ; neutralize with KHO ; a yellow, crystalline precipitate. 5. With FeSO_4 soln., a

lilac color. 6. Float on H_2SO_4 , add powdered KNO_3 ; a violet color.

981. *Describe the symptoms of phenol poisoning.*

Those portions of the skin and mucous membrane which have been in contact with the poison are whitened and hardened. There are burning pains in the mouth, œsophagus, and stomach, and vomiting; lowering of the pulse and temperature, contraction of the pupils, stupor, syncope, and collapse, terminating in death. The urine, clear and of the normal color when voided, becomes rapidly greenish, and finally dark olive green or almost black.

982. *What treatment should be adopted in poisoning by phenol?*

The administration of emetics, or the use of the stomach pump, *used with great caution*; albumen (raw white of egg); and stimulation.

983. *How is picric acid derived from phenol?*

By boiling phenol with HNO_3 , three atoms of H are removed from the former substance, and are replaced by three groups $(\text{NO}_2)'$, with formation of $\text{C}_6\text{H}_2(\text{OH})(\text{NO}_2)_3$ = trinitrophenol = picric or carbazotic acid.

984. *State the properties of trinitrophenol.*

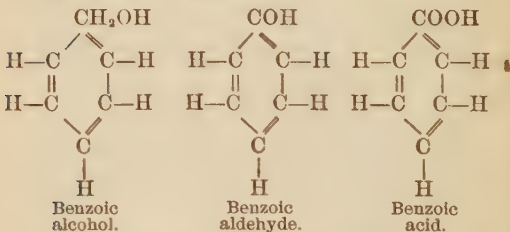
Forms prismatic, sulfur-yellow crystals, very bitter, sparingly soluble in water, quite soluble in alcohol or ether. It is acid in reaction, and forms salts called picrates. These are all decomposed by heat, usually with an explosion. Its coloring power is very intense, and it is used in dyeing.

(For other PHENOL DERIVATIVES, DIATOMIC and TRIATOMIC PHENOLS, and PHENOL DYES, see Manual, pp. 404-411.)

985. *Explain the relations between benzoic alcohol, benzoic aldehyde, and benzoic acid, and give their graphic formulæ.*

Benzoic alcohol is benzene, one of whose H atoms has been replaced by the group CH_2OH , characteristic of the monoatomic alcohols (see Q. 717). Benzoic aldehyde is derivable from it by oxidation, limited to the removal of two H atoms (see Q. 761). Benzoic acid is derivable from benzoic aldehyde or alcohol by more complete oxidation, attended by introduction of an O atom (see Q. 745).

The graphic formulæ are :



986. *Of what oil is benzoic aldehyde the chief constituent, and what are its most prominent properties?*

Oil of bitter almonds. It is a colorless oil, sparingly soluble in water, readily converted by oxidizing agents into benzoic acid. It is, *when pure*, non-poisonous, the toxic powers of the commercial oil of bitter almonds being due to the presence of hydrocyanic acid.

987. *How does benzoic acid exist in nature, and how is it obtained?*

It exists in a number of resins and balsams, notably in benzoin, from which it is obtained by sublimation. The benzoin is placed in a porcelain capsule, covered with filter paper, over which is a cone of writing paper. On heating the capsule the acid is volatilized, passes through the filter paper, and condenses in the cone.

988. *State the properties of benzoic acid.*

It crystallizes in long, white, flexible needles, or in thin laminæ, which fuse at 122° ($251^{\circ}.6$ F.) and sublime at 145° (293° F.). Sparingly soluble in cold water, more soluble in boiling water, easily soluble in alcohol, ether, and the fatty and ethereal oils. When pure, it is odorless and has a faint acid taste.

989. *Into what substance is benzoic acid converted in passing through the animal economy?*

Hippuric acid.

990. *Give the occurrence and properties of hippuric acid.*

It is found in human urine in small and variable quantities, and abundantly in that of the herbivora. It crystallizes in long, colorless prisms; sparingly soluble in cold, readily soluble in hot water and in alcohol. It is monobasic. When heated alone, when boiled with the mineral acids or alkalies, and under the influence of certain ferments, as in putrid urine, it is decomposed, with formation of benzoic acid.

991. *What is the constitution of salicylic acid?*

It has the same relation to phenol that benzoic acid has to benzene. It is, therefore, phenol in

which an atom of hydrogen has been replaced by the group $(\text{CO}_2\text{H})'$: $\text{C}_6\text{H}_4(\text{OH})\text{COOH} = \text{C}_7\text{H}_6\text{O}_3$.

992. *How does it exist in nature, and how is it prepared?*

It exists, as its methylic ether, in oil of winter-green, from which it may be obtained. It is, however, more cheaply prepared by the combined action of sodium and carbonic anhydrid upon phenol.

993. *State its properties.*

It crystallizes in colorless prisms; odorless; has a sweetish sour taste; fuses at 158° ($316^\circ.4$ F.). At moderately elevated temperatures it sublimes; at higher temperatures, or when rapidly heated, it is decomposed into phenol and carbon dioxid. Sparingly soluble in cold, readily soluble in warm water and in alcohol or ether; its solutions are acid. It is a monobasic acid. It is a valuable disinfectant.

994. *How is gallic acid obtained?*

By exposing moistened gall nuts to the air for a month or more. Under the influence of a peculiar ferment, the tannic acid of the galls is converted into gallic acid, which is then extracted by subjecting the pasty mass to pressure, and purified by solution, filtration through purified animal charcoal, and crystallization.

995. *Give the principal properties of gallic acid.*

It forms white, silky needles with 1Aq. Odorless; has a sweetish, astringent taste, and an acid reaction; sparingly soluble in cold, readily soluble in hot water, and abundantly soluble in alcohol. It does not precipitate gelatin or the alkaloids from their solutions (distinction from tannin).

When heated to 210° (470° F.), it is decomposed into pyrogallol (= pyrogallic acid) and carbon dioxid.

996. *How is nitrobenzol obtained, and what relation does it bear to benzene?*

By the action of fuming HNO_3 on benzene. It is benzene in which one H atom has been displaced by $\text{NO}_2 = \text{C}_6\text{H}_5(\text{NO}_2)$.

997. *Under what other names is it known, and what are its properties and uses?*

It is known as essence of mirbane, or artificial oil of bitter almonds. It is a yellow, oily liquid, having the odor of bitter almonds; very sparingly soluble in water, but poisonous. It is used as a substitute for oil of bitter almonds, but principally in the manufacture of anilin.

998. *Explain the constitution of anilin and its formation from nitrobenzene*

It is benzene in which one H is replaced by the group $(\text{NH}_2)'$. It may also be considered as phenylamin, i.e., ammonia in which one H has been replaced by the radical phenyl, $(\text{C}_6\text{H}_5)'$. By the action of reducing agents upon $\text{C}_6\text{H}_5(\text{NO})_2$, the O_2 is removed, and H_2 substituted: $\text{C}_6\text{H}_5(\text{NO})_2 + 3\text{H}_2 = \text{C}_6\text{H}_5(\text{N}'''\text{H}_2)' + 2\text{H}_2\text{O}$.

999. *Describe the physical properties of anilin.*

When pure, it is a colorless, oily liquid, of a peculiar, aromatic odor, boiling at $184^{\circ}.8$ (364° 6 F.), sparingly soluble in water. The commercial product is brown, and has the odor of coal tar.

1000. *For what purpose is anilin used in the arts?*

In the manufacture of a great number of

brilliant dyes, the most important of which is the red *magenta* or *fuchsin*.

(See Manual, pp. 435, 436.)

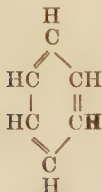
1001. *How is antifebrin related to anilin.*

It is *acetanilid*, *i.e.*, anilin in which one hydrogen atom has been replaced by the radical (C_2H_3O) of acetic acid : $C_6H_5(NH.C_2H_3O)$.

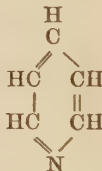
(For PHENYLAMINS, HYDRAZINS, AZO- and DIAZO derivatives, see Manual, pp. 420-422.)

PYRIDIN BASES.

1002. *Write the graphic formulæ of benzene and of pyridin.*



Benzene.



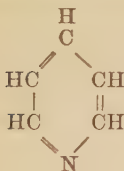
Pyridin.

1003. *Describe the source and properties of pyridin.*

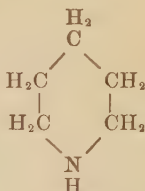
It exists in *oil of Dippel*, or *bone oil*, produced by the dry distillation of bones, hoofs, etc., and is a product of decomposition of *piperidin*. It is a colorless liquid, having a very penetrating odor. Is strongly alkaline and combines with acids to form salts in the same manner as ammonia. It is therefore an alkaloid (see Q. 1023) of animal origin.

(For superior homologues and other derivatives of pyridin, see Manual, pp. 423-429.)

1004. *Explain by graphic formula the relation between pyridin and piperidin.*



Pyridin.



Piperidin.

1005. *Name four vegetable alkaloids which are derivatives of piperidin, and the sources whence they are obtained.*

Piperin, from black and white pepper; Coniïn, from *Conium maculatum*; Atropin, from *Atropa belladonna*; Cocaïn, from *Erythroxylon coca*.

1006. *How is coniïn related to piperidin?*

It is piperidin in which (C_3H_7) has been substituted for H. Its formula is therefore $\text{C}_5\text{NH}_{10}(\text{C}_3\text{H}_7)$. It has been obtained synthetically from picolin, a superior homologue of pyridin.

1007. *Describe the properties of coniïn.*

It is an oily liquid, lighter than H_2O , having a disagreeable, penetrating odor; sparingly soluble in H_2O , readily in alcohol and ether. It has a strongly alkaline reaction and forms neutral, amorphous salts with most acids. It deteriorates rapidly on exposure to air, becomes colored, and finally resinous.

1008. *Describe the prominent symptoms of poisoning by hemlock or its alkaloid.*

The action of the plant begins in a half-hour or less, that of the alkaloid almost immediately. There are headache, derangement of vision, with dilated and fixed pupils, interference with deglutition, and great drowsiness. Muscular weakness, increasing to paralysis, begins at the extremities and extends to the muscles of respiration, causing death by apnoea in from one to three hours.

1009. *What treatment should be followed?*

The unabsorbed poison is to be removed by the pump or emetics. Stimulants are indicated, and the performance of artificial respiration.

1010. *What are the characters of atropin?*

It crystallizes in silky needles, having a faint yellowish tinge and persistent, bitter taste; odorless; sparingly soluble in water, readily in alcohol.

1011. *What salt of atropium is used in medicine?*

The sulfate.

1012. *Describe the prominent symptoms of poisoning by atropin or belladonna.*

Giddiness, drowsiness, great thirst, dryness of the mouth and fauces, and difficulty in deglutition. The pulse is stronger than normal, the countenance is flushed, the eyes sparkling and prominent, with widely dilated pupils and disturbances of vision. The power of articulation is lost early. The extremities are the seat of partial paralysis, preceded by numbness. Later there is delirium, sometimes maniacal, sometimes attended with pleasing hallucinations or spectral illusions.

In fatal cases, the patient passes into a condition of coma terminating in death. In cases of recovery, the patient sleeps quietly, and awakes unconscious of previous mental disturbances.

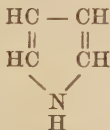
1013. *How should cases of poisoning by this and other alkaloids be treated?*

The chief indication is to remove any portion of the poison remaining in the stomach, as rapidly as possible; an emetic of zinc sulfate should be given, or, if this be not feasible, a hypodermic injection of apomorphin. The stomach pump should be used and the stomach washed out with infusion of tea, or with water holding powdered animal charcoal in suspension. Chemical antidotes are of little value. Where physiological antidotes exist they should be used.

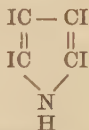
(For constitution of and tests for atropin and cocaïn, see Manual, pp. 427, 428.)

COMPOUNDS WITH PENTAGONAL NUCLEI.

1014. *Give the graphic formulæ of pyrrol and of iodol.*



Pyrrol.



Iodol (Tetriodopyrrol.)

1015. *What important medicine is a derivative of pyrrol?*

Antipyrin. (See Manual, pp. 430-432.)

DERIVATIVES OF INCOMPLETE BENZENIC
HYDROCARBONS.

1016. *Is cholesterin related to the fats, and what is its constitution?*

It is not. It is an alcohol, having the composition $(C_{26}H_{43})' \left. \begin{matrix} \\ H \end{matrix} \right\} O$.

1017. *State the physical characters of cholesterin.*

A white solid, crystallizing in plates or needles; tasteless, odorless, unctuous to the touch, insoluble in water, sparingly soluble in cold alcohol, and readily in hot alcohol or ether. Melts at 145° (293° F.).

1018. *Give some of the reactions of cholesterin.*

Treated with HNO_3 , the solution evaporated nearly to dryness and NH_4HO added: a brick-red color. With sulfuric acid and chloroform, a red color, changing to violet, blue, green. Not affected by potash solution.

1019. *In what parts of the economy does it occur?*

In blood, bile, nerve tissue. Pathologically in gall stones, fluids of hydrocele and of certain cysts. Tumors consisting almost entirely of cholesterin have occurred in the brain.

1020. *What are the cholesterids?*

Ethers of cholesterin, formed by the union of fatty acids with cholesterin, and corresponding to the glycerids (see Q. 902-905) and other compound ethers (see Q. 757). Such cholesterids constitute *lanolin*, a neutral, fatty substance obtained from wool fat and used as a vehicle in ointments.

BI- AND POLYBENZOIC HYDROCARBONS.

1021. *How are the bi- and polybenzoic hydrocarbons constituted?*

By the linking or fusion together of two or more benzene nuclei.

1022. *Name the more important of these hydrocarbons, and indicate in what connection they are of interest.*

Triphenylmethan, $(C_6H_5)_3CH$, a base many of whose derivatives are used as anilin dyes; Diphenyl, $(C_6H_5)(C_6H_5)$, one of whose derivatives, Dipyridyl, $(C_5NH_4)(C_5NH_4)$, is the nucleus of the alkaloid nicotin; Phenanthrene, $C_{14}H_{10}$, which is the nucleus of the alkaloids morphin and codeïn; Naphthalene, $C_{10}H_8$, some of whose derivatives are used as dyes, others, the Naphthols, corresponding to the phenols, as antiseptics, and one of whose derivatives, Quinolin, C_9H_7N , is the nucleus of the cinchona alkaloids; Anthracene, $C_{14}H_{10}$, from which artificial madder, or Alizarin, is obtained.

(See Manual, pp. 434-450.)

ALKALOIDS.

1023. *What is an alkaloid?*

An organic, nitrogenized substance, alkaline in reaction, and capable of combining with acids to form salts, in the same way as does ammonia. They are sometimes known as vegetable bases or alkalies.

1024. *Into what two classes are the alkaloids divided, and wherein do they differ?*

Volatile and fixed. The volatile alkaloids are

oily, readily volatile without decomposition, and consist of C, H, and N. The fixed alkaloids are for the most part solid and crystalline, not, or only partially volatile without decomposition, and consist of C, H, N, and O.

1025. *Describe the behavior of the alkaloids and of their salts toward solvents.*

As a rule, the free alkaloids are insoluble or very slightly soluble in water, more soluble in chloroform, petroleum ether, benzene, and amylic alcohol. Their salts are insoluble in the last-named solvents, but generally soluble in water and in alcohol.

1026. *How should the names of the alkaloidal salts be constructed?*

In the same way as those of the corresponding ammoniacal salts: thus, as ammonia combines with hydrochloric acid to produce ammonium chlorid, so morphia (or morphin) combines with the same acid to produce morphium chlorid.

1027. *Describe some of the general reactions of the alkaloids.*

They are precipitated from solutions of their salts by KHO, NaHO, NH_4HO , CaH_2O_2 , BaH_2O_2 , and MgO. Their solutions form yellowish or white precipitates with solutions of phosphomolybdic acid, potassium iodhydrargyrate, and other "general reagents."

1028. *Name the principal volatile alkaloids.*

Nicotin, coniïn, sparteïn.

1029. *Give the source and properties of nicotin.*

It is obtained from tobacco. It is an oily, colorless, transparent liquid, heavier than water, having a burning taste and a faint odor of to-

bacco, which becomes more powerful upon the application of heat ; it is quite volatile, and its vapors are very irritating. Very soluble in water, alcohol, and ether. When exposed to the air it absorbs moisture, becomes brown, and is oxidized. It is very alkaline, and forms well-defined salts with acids. It is a very violent poison, and very rapid in its action.

1030. *Describe the prominent symptoms of poisoning by tobacco or nicotin.*

The alkaloid has caused death in three minutes, tobacco in fifteen minutes. The patient first suffers from giddiness, trembling of the limbs, depression, cold sweats, and confusion of intellect. The pulse gradually becomes weaker, the respiration more difficult, and paralysis more extended. Death is usually preceded by convulsions.

1031. *What should be the treatment in nicotin tobacco poisoning?*

Wash out the stomach with water, or better, with infusion of tea holding charcoal in suspension ; opium, stimulants.

OPIUM ALKALOIDS.

1032. *Name the principal alkaloids existing in opium.*

Morphin, codeïn, narceïn, narcotin, thebaïn, papaverin.

1033. *In what form do these probably exist in opium?*

In combination with a peculiar organic acid known as meconic acid, or with lactic acid.

1034. *State the properties of morphin.*

It crystallizes in colorless, transparent, odorless prisms, having a persistent, bitter taste; soluble in 500 parts of boiling water, insoluble in ether and chloroform, soluble in 13 parts of boiling alcohol. Morphin and its salts are very prone to oxidation.

1035. *What salts of morphium are officinal?*

The acetate, chlorid, and sulfate.

1036. *Give tests for the presence of morphin.*

1. It is colored orange, changing to yellow, by HNO_3 . 2. If iodic acid and a drop of chloroform be added to solution of a morphin salt, free iodine is liberated, which colors the chloroform violet. If now dilute NH_4HO be floated on the liquid, a dark brownish zone is formed. 3. Solution of neutral Fe_2Cl_6 gives a blue color with morphin. 4. Moisten the solid with HCl to which a small quantity of H_2SO_4 has been added, evaporate on the water bath until the HCl is expelled: a violet-colored, liquid residue remains. Add to this some HCl , and neutralize with solid NaHCO_3 in slight excess: a pink or rose color is produced, most distinctly visible on the bubbles. Add a drop of H_2O and a drop or two of tincture of iodine: a green color. 5. Moisten the solid with concentrated H_2SO_4 , and heat cautiously until white fumes just begin to appear, cool, and touch the liquid with a glass rod moistened with dilute HNO_3 : a fine blue-violet color, changing to red and then to orange. 6. Fröhde's reagent (a fresh solution of ammonium molybdate in concentrated H_2SO_4) gives a violet color, changing to blue, dirty green, and faint pink.

1037. *What relation does apomorphin bear to morphin, and how is it produced?*

It is morphin minus H_2O . It is produced by heating morphin with HCl to 150° ($302^\circ F.$) under pressure.

(See Manual, pp. 440-445.)

1038. *Give a test for the presence of meconic acid.*

With a solution of neutral Fe_2Cl_6 a red color is produced, which is not discharged upon the addition of mineral acids or of solution of $HgCl_2$.

1039. *How much morphin does opium contain?*

Ten to fifteen per cent.

1040. *Which is the most actively poisonous of the opium alkaloids?*

Thebain.

1041. *Describe the prominent symptoms of poisoning by opium and its preparations.*

At first there is usually a period of excitation, marked by restlessness, great physical activity, loquacity, and hallucinations. The patient then becomes weary, dull, and drowsy; he yields to the desire for sleep, from which at first he may be roused. The lips are livid, the face pale, the pupils contracted, and the surface bathed in perspiration. The condition of somnolence rapidly passes into narcosis. The patient cannot be roused, and lies motionless and senseless, with completely relaxed muscles. The pulse, at first full and strong, becomes feeble, slow, irregular, and easily compressible; the respiration slow, shallow, stertorous, and accompanied by mucous râles. The patient rapidly becomes comatose,

and, in fatal cases, dies in from forty-five minutes to fifty-six hours, usually in from twelve to eighteen hours. In cases of recovery after the stage of narcosis, the pulse and respiration gradually return to the normal, and the condition of coma passes into one of deep sleep, lasting twenty-four to thirty-six hours.

1042. *What treatment should be followed in opium poisoning?*

Unabsorbed poison is to be removed by washing the stomach with infusion of tea containing powdered charcoal, or by emetics of zinc sulfate or of apomorphin. The patient is to be kept in motion to prevent sleep. Cold affusions. Artificial respiration, continued so long as the heart's action is perceptible.

CINCHONA ALKALOIDS.

1043. *Name the two most important alkaloids of cinchona bark.*

Quinin and cinchonin.

1044. *With what peculiar acid are they combined in nature?*

Kinic acid.

1045. *State the physical properties of quinin.*

A light, white, amorphous powder, without odor, having a persistent, bitter taste and an alkaline reaction. Very sparingly soluble in water, readily soluble in alcohol, chloroform, and ether. It separates, on evaporation of its alcoholic or ethereal solution, in crystals containing 3Aq.

1046. *Explain the solubility of quinin in dilute H_2SO_4 .*

The quinin combines with the acid to form the bisulfate, which is soluble.

1047. *What salt of quinium is commonly used in medicine, and what are its physical properties?*

The sulfate. It crystallizes in thin, light, white needles, with 7Aq; sparingly soluble in H_2O , readily in boiling alcohol and in ether. It dissolves readily in dilute H_2SO_4 , the soluble bisulfate being formed. Solutions of this salt, although they are colorless by transmitted light, present beautiful pale-blue reflections.

1048. *By what reactions may quinin be recognized?*

1. By the blue reflections (fluorescence) of its solution in dilute H_2SO_4 . 2 When chlorin water and aqua ammoniæ are added to quinin solution it assumes a green color. 3. A deep red color is produced in solutions of quinin when chlorin water, potassium ferrocyanid, and aqua ammoniæ are added in the order named.

1049. *How is quinin adulterated?*

With gypsum, stearic acid, starch, salicin, and cinchonium sulfate.

1050. *How may the presence of mineral substances be detected?*

By heating to redness; if any mineral matter be present it remains after heating, while pure quinin is entirely volatilized.

1051. *How is the presence of cinchonin detected?*

Place a gram of the sample in a test tube, add 10-15 grams of ether and 2 grams of aqua ammoniæ, shake, and allow the mixture to separate

into two layers ; if cinchonin be present it will appear as a precipitate in the lower layer.

1052. *How may the other adulterations named be detected ?*

Stearic acid may be detected by its insolubility in dilute H_2SO_4 ; starch by its insolubility in boiling alcohol ; and salicin by the red color produced upon the addition of H_2SO_4 .

STRYCHNOS ALKALOIDS.

1053. *What two important alkaloids belong to this class ?*

Strychnin and brucin.

1054. *Give the properties of strychnin.*

It crystallizes in small, transparent, four-sided prisms ; odorless, having an intensely bitter taste and an alkaline reaction ; very sparingly soluble in water, soluble in benzene, chloroform, and boiling dilute alcohol, insoluble in absolute alcohol, ether, and solutions of the alkalies. It is a strong base, neutralizing acids and forming salts, most of which are crystalline, soluble in water, and very bitter.

1055. *Describe the tests for strychnin.*

1. The alkaloid forms a colorless solution with concentrated H_2SO_4 . If a crystal of potassium dichromate be drawn through this solution, it is followed by a track of color which is first (for an instant) blue, then violet, then rose-colored, and finally yellow. 2. The alkaloid and its salts are intensely and persistently bitter. 3. Injected into a lymph pouch of a frog, it causes violent tetanic spasms and opisthotonos.

1056. *Describe the prominent symptoms of strychnin poisoning.*

The action of the poison is usually rapid. The characteristic symptoms are tetanic spasms, with opisthotonos, sometimes emprosthotonos or pleurosthotonos. The pain is intense, and the patient suffers from thirst and is in apprehension of death. The spasms increase in frequency and in duration, and when death follows it is either during a spasm, by paralysis of the muscles of respiration, or in an interval, from exhaustion.

1057. *What treatment should be followed in poisoning by strychnin?*

Unabsorbed poison is to be removed as directed in opium poisoning, and the convulsions are to be arrested or mitigated by bringing the patient under the influence of chloral or chloroform as rapidly as possible. The patient is to be kept as quiet as possible.

1058. *Give a test for brucin.*

Upon the addition of HNO_3 a bright red color is produced, which gradually turns to yellow on the addition of stannous chlorid, or to reddish-violet on the addition of ammonium sulphhydrate.

1059. *What are ptomaïns, leucomaïns, and toxins?*

They are alkaloids of animal origin. The ptomaïns are products of the putrefaction of dead animal tissues or fluids. The leucomaïns are normal products of the living body. The toxins are actively poisonous animal alkaloids, either the products of pathogenic bacteria or ptomaïns or leucomaïns.

1060. *Name and state the origin of some of the best-known toxins.*

Typhotoxin, from the cultures of the Koch-Eberth typhoid bacillus; Tetanin, from the cultures of a bacillus from wounds causing tetanus; Mytilotoxin, from poisonous mussels; Mydalein, a putrid product; Mydatoxin, from the cultures of the comma bacillus. Unnamed toxins also exist in normal urine.

(See Q. 856-863, and Manual, pp. 470-472.)

(For INDIGO and related substances see Manual, pp. 450-452.)

TEREBENTHIN SERIES.

1060a. *How is oil of turpentine obtained?*

A resinous juice, exuded from incisions in certain varieties of pine, and known as crude turpentine, is distilled with water; the volatile spirit or oil of turpentine passes over, while rosin remains in the still.

1061. *State the prominent properties of oil of turpentine.*

A colorless liquid, having a characteristic odor; lighter than water; boiling at 156° ($312^{\circ}.8$ F.); readily inflammable, burning with a smoky flame; a solvent for phosphorus, sulfur, india-rubber, and many resins. When exposed to the air it assumes a yellow tinge, becomes thicker, and absorbs oxygen.

1061a. *Describe the prominent properties of caoutchouc.*

It is a soft, flexible, yellowish semi-solid; insoluble in water and in alcohol, not acted upon

by dilute acids. It has the property of combining with sulfur to produce "vulcanized rubber," a very elastic and impermeable material; and "ebonite," or "hard rubber," a somewhat flexible, although brittle, solid, valuable as an insulating medium.

1062. *Describe the prominent properties of gutta-percha.*

It is a tough, flexible, but inelastic substance. A good insulating medium, for which purpose it is principally used. It dissolves in chloroform.

1063. *What varieties of camphor occur in commerce?*

Borneo camphor, or Borneol, and Chinese, or Japanese, camphor. The latter contains two atoms of hydrogen less than the former.

1064. *State the more prominent properties of Japanese camphor.*

White, semi-transparent crystals, having a strong, aromatic odor and a sharp, bitter taste; very volatile; sparingly soluble in water, readily soluble in alcohol, ether, and the oils.

SUBSTANCES WHOSE CONSTITUTION IS UNKNOWN.

GLUCOSIDS.

1065. *What is the characteristic property of the glucosids?*

That of splitting up, under the influence of the acids, alkalies, and of certain ferments, into a sugar (usually glucose) and some other substance.

1066. *Mention some of the more important glucosids, and the sources from which they are obtained.*

Amygdalin from bitter almonds; digitalin, digitonin, digitalein, and digitoxin from digitalis; jalapin from scammony; convolvulin from jalap; salicin from willow bark; santonin from artemisia; solanin from dulcamara.

1067. *Describe the prominent symptoms of poisoning by digitalis.*

Nausea, and occasionally vomiting. Sometimes colic and diarrhoea. After two or three hours, marked diminution in the frequency of the pulse, which may fall to 40 or even 25. Dyspnoea, attended by a sense of oppression in the chest and coldness of the extremities. Headache, vertigo, and tendency to sleep. Usually attacks of syncope occur, provoked sometimes by the slightest movement of the patient. Death is

generally by syncope, sometimes after several hours of coma succeeded by convulsions.

1068. *What treatment should be adopted in poisoning by digitalis?*

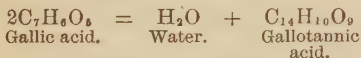
The patient must be kept strictly in the recumbent position. The stomach should be washed out with infusion of tea by the stomach pump or siphon. Stimulants should be given.

1069. *What are the tannins or tannic acids?*

Substances of different composition existing in various barks, leaves, etc. They are amorphous bodies, having a faintly acid reaction, soluble in H_2O , and astringent. They all precipitate with albumen, the alkaloids, and the ferric salts; and they also form imputrescible compounds with albuminoid and gelatinoid substances. They exist notably in oak bark, gall nuts, cinchona, coffee. They are, with one possible exception, glucosids.

1070. *Whence is the Acidum tannicum, U. S. P., obtained, and what are its chemical name and formula?*

From nutgalls, which are excrescences produced upon the oak by the puncture of an insect. It is known as gallotannic acid. It has the formula $C_{14}H_{10}O_9$, and is considered as being formed by the union of two molecules of gallic acid, with loss of a molecule of water:



1071. *Give the prominent properties of gallotannic acid.*

A light yellowish, amorphous powder, highly

astringent. Readily soluble in H_2O , less so in alcohol, insoluble in ether. It has acid properties, and forms salts which are amorphous.

1072. *What class of medicinal substances contain tannin?*

The vegetable astringents.

1073. *Why are the alkaloids and tartar emetic incompatible with tannic acid?*

Because insoluble tannates are formed.

1074. *What is formed when tannic acid and a ferric compound are brought together?*

Black ink.

ALBUMINOID SUBSTANCES.

PROTEID BODIES.

1075. *State the general properties of albuminoid substances.*

They are nitrogenized bodies, for the most part incapable of crystallization, having, when dry, the appearance of gum arabic, odorless, insipid, insoluble in ether and alcohol. Their solubility in water varies according to the temperature and the presence or absence of alkalies, acids, and mineral salts. They enter very readily into the series of changes designated by the term putrefaction. They are all the products of organized bodies, to whose life they are indispensable.

1076. *What is understood by coagulation?*

The property of many albuminoid substances of being converted into insoluble modifications by the action of heat, mineral acids, alcohol, and certain metallic salts. When once converted into

these modifications, the albuminoids will not return to their primitive form.

(For composition and products of decomposition of albuminoids, see Manual, pp. 472-475.)

1077. *What is putrefaction?*

It is decomposition of dead albuminoid matter under the influence and as a result of the processes of nutrition of certain bacteria, and attended by the evolution of more or less fetid products.

1078. *What conditions are necessary to putrefaction?*

The presence of albuminoid matter, bacteria, air and water, and a temperature between 5° and 90° (41° - 194° F.).

1079. *Explain the distinctions between the terms germicide, antiseptic, disinfectant, deodorant.*

Germicides are substances or agents which destroy bacteria and their germs—e.g., mercuric chlorid and heat. *Antiseptics* are substances which prevent or restrain putrefaction. They are either germicides, which act by destroying the bacteria causing putrefaction, or agents which, without destroying the vitality of these organisms, render the conditions unfavorable for their development. Thus cold and the aluminium salts are antiseptic but not germicidal. *Disinfectants* are substances or agents which restrain infectious diseases by destroying or removing their specific poisons. Some disinfectants are germicides, as chlorin; others act by dilution or removal without being germicides, as soap and water and fresh air. *Deodorants* are substances which destroy the odorous products of putrefaction. Thus one of the actions of SO_2 is to destroy H_2S .

1080. *Name some of the products of putrefaction.*

The products of putrefaction vary with the conditions. The most prominent are: (1) Inorganic products, such as N, H, H_2S , NH_3 ; and simple organic compounds, such as CO_2 and hydrocarbons. (2) Acids of the acetic series in great abundance, and acids of the oxalic and lactic series. (3) Non-aromatic monamins and diamins, among which are included some of the ptomaines (see Q. 770-775; 856-859). (4) Aromatic products, among which are phenols, phenylic derivatives, indol, scatol, pyridin derivatives, and some of the ptomaines.

1081. *What is adipocere?*

A substance resembling tallow, and consisting chiefly of palmitate, stearate, and oleate of ammonium, with an undetermined albuminoid body and mineral salts. It is produced by a modified putrefaction.

1082. *Give "color reactions" for albuminoid substances.*

1. They are dissolved by boiling concentrated HCl, the solution being violet-red in color. 2. They turn yellow with concentrated HNO_3 , the color changing to orange on addition of NH_4HO . 3. A solution of an albuminoid in excess of glacial acetic acid is colored violet and rendered faintly fluorescent by concentrated H_2SO_4 . 4. Solution of mercuric nitrate with excess of nitric acid (Milon's reagent) gives a fine red color when warmed with an albuminous substance. 5. With Pettenkofer's reaction the same result is obtained as with the biliary salts.

(For other tests see Q. 1088-1091, and Manual, pp. 475, 476. For classification see Manual, pp. 476, 477.)

1083. *Wherein do albumens and globulins differ from each other?*

The albumens are soluble in pure water; the globulins are insoluble in pure water, but dissolve in dilute solutions of neutral salts (NaCl, KCl, MgSO₄, etc.). Both are coagulated by heat.

1084. *Describe the composition of egg albumen.*

It consists of two globulins and three albumens, all coagulable by heat, but at different temperatures ranging from 57°.5 (135°.5 F.) to 82° (179°.6 F.), and peptones (see Q. 1098-1102), which last increase in quantity as the egg becomes stale.

1085. *Where does serum albumen exist in the animal body?*

In the blood serum, lymph, chyle, pericardial fluid, the fluids of cysts and transudations, and pathologically in the urine. Human serum albumen consists of three distinct proteids coagulating at 73° (163°.4 F.), 77° (170°.6 F.), and 84° (183°.2 F.).

1086. *How is the sp. gr. of the urine affected by the presence of serum albumen?*

It is lowered.

1087. *Why should the urine be tested for albumen before examining for sugar?*

Because albumen interferes with the tests for sugar. If present, it must therefore be removed before examining for sugar. (See Q. 938.)

1088. *How is urine tested for albumen?*

By the action of heat and of nitric acid; both

tests must be used, as neither is of itself conclusive.

1089. *Describe the heat test.*

The reaction is first observed. If it be acid, the urine is simply heated to near the boiling point. If the urine be neutral or alkaline, it is rendered *faintly* acid by the addition of dilute acetic acid, and heated. If albumen be present, a coagulum is formed, varying in quantity from a faint cloudiness to entire solidification, according to the quantity of albumen present. The coagulum is not redissolved upon the addition of HNO_3 .

1090. *What are the sources of error to be avoided?*

Albumen is soluble in alkaline liquids. The urine is therefore rendered acid, to prevent small quantities of albumen remaining in solution upon the application of heat, and thus escaping detection. Albumen is also slightly soluble in dilute HNO_3 , therefore acetic acid is used. It is also soluble in a large amount of acetic acid, therefore the addition of acetic acid should be limited to the amount necessary to produce an acid reaction. A urine rich in earthy phosphates deposits, on boiling, a precipitate closely resembling that of coagulated albumen, therefore HNO_3 is added after heating. It dissolves the phosphates, but does not affect the albumen. Nitric acid cannot be used alone as a test for albumen, because if the urine contain an excess of urates, these are decomposed upon the addition of acid, and the almost insoluble uric acid is precipitated, and might easily be mistaken for albumen.

1091. *Describe Heller's modification of the nitric acid test.*

Place in a test tube a layer of HNO_3 about 2

centim. in thickness ; then, with a pipette, carefully float upon the surface of this a layer of the urine in such a manner that the liquids do not mix. If albumen be present, a cloudy ring appears *at* the point of junction of the two layers, the borders of the cloud being sharply defined. A cloudy ring may be formed by the presence of an excess of urates, but in this case it is not *at*, but *above* the point of junction of the layers, and its upper border is not sharply defined, but fades off gradually.

1092. *Give a process for determining the quantity of albumen in urine.*

Heat a known volume of acid urine to near the boiling point ; collect the coagula upon a weighed filter, wash with water ; dry the filter with adhering albumen at 100° (212° F.) ; weigh. The difference between the two weighings indicates the quantity of dry albumen in the volume of urine used. [Some authors direct to weigh the filter and albumen wet ; when this is done there is no approach to accuracy, as it is impossible to judge how much water is being weighed.]

1093. *Why should albuminous urine always be examined microscopically ?*

To determine the presence or absence of blood or pus corpuscles, spermatozoa, and casts. When the urine contains blood, pus, or spermatic fluid, it is always slightly albuminous. The presence of albumen has then no clinical importance beyond that attaching to the fluids named. Casts are never present in the urine of persons free from organic disease of the kidneys.

1094. *Give the names and sources of some of the more important globulins.*

Vitelin exists in the yolk of eggs and in the crystalline lens. *Myosin* is one of the principal constituents of muscular fibre in rigor mortis. *Paraglobulin* exists in blood serum, pericardial fluid, hydrocele fluid, lymph and chyle, and, accompanying serum albumen, in albuminous urine. It is precipitated from dilute solution by CO_2 , or by dissolving magnesium sulfate in the solution to saturation. *Paraglobulin* may be separated from serum albumen by MgSO_4 . *Fibrinogen* occurs in blood plasma, and yields fibrin during coagulation of blood.

1095. *State the characters of fibrin.*

White, elastic filaments interlaced in all directions, insoluble in water. When treated with dilute acids, it swells and gradually dissolves, although usually incompletely.

1096. *Describe the alkali-albumens and acid-albumens.*

Alkali-albumen is precipitated in white flocks by the addition of acetic acid to an aqueous solution of the jelly-like product obtained by the action of a caustic alkali upon an albumen. Their solutions are acid in reaction, and are only coagulated at a temperature somewhat above 100° (212° F.). The *acid-albumens*, or *syntonins*, are white, gelatinous substances produced by the action of dilute acids upon albuminoids. They are soluble in very dilute HCl and in alkaline solutions, and are precipitated by neutral salts but not by heat.

1097. *Describe the albumoses or propeptones.*

They are products produced during peptic or pancreatic digestion of albuminoids, intermediate between acid-albumens and peptones. They differ from the peptones in being precipitated by acetic acid, by many metallic salts, NaCl and HNO_3 ; and from the albumens in the property of their precipitates of dissolving on the application of heat and reappearing on cooling. Albumoses are produced by the action of natural or artificial gastric juice on fibrin, egg and serum albumen, the globulins, and casein.

1098. *Into what substance are all the albuminous bodies converted by the action of the gastric juice?*

Into albuminose or peptone.

1099. *By what constituents of the gastric juice is this change brought about?*

By the combined action of the free acid and a substance, known as pepsin, peculiar to the gastric juice. Neither pepsin nor an acid will produce the change alone.

1100. *By what agency other than pepsin, are albuminous substances converted into albuminose during digestion?*

By the action of trypsin, a constituent of the pancreatic secretion, which effects the same transformation, but by a different method, and in an alkaline reaction.

1101. *In what important point does albuminose differ from other albuminous substances?*

In being capable of dialysis—i.e., passing through animal membranes, which other albuminous substances are incapable of. It is in the form of albuminose that the food elements of this class pass from the intestine into the blood.

1102. *By what test may peptone be distinguished from other albuminoids?*

By the "biuret test": Add a mere trace of CuSO_4 solution, and then KHO or NaHO solution, and warm; a purple or reddish-violet color is produced.

1103. *What is peptoxin?*

Peptone is one of the earliest products of putrefaction, and under these conditions is accompanied by peptoxin, a crystallizable and actively poisonous substance.

1104. *By what names is the coloring matter of the blood known?*

Hæmoglobin, hæmatocrystallin, and cruorin; the first is the name now in general use.

1105. *In what portion of the blood does it exist?*

In the corpuscles.

1106. *What are its physical properties?*

It is, when pure, a crystalline solid, more or less soluble in water, soluble in dilute alcohol and in dilute solutions of the alkalies; red or purple in color. It dialyzes very slowly, although it crystallizes with more or less facility.

1107. *How does hæmoglobin from the blood of different kinds of animals differ in physical properties?*

In the facility with which it forms crystals and in the forms of the crystals. In its solubility. The crystals from the blood of the ox are very readily soluble in water, while those from the blood of the raven are almost insoluble in that fluid.

1108. *Of what elements is hæmoglobin composed?*

C, H, N, O, S, and Fe.

1109. *Explain the change which hæmoglobin undergoes in passing through the lungs.*

Hæmoglobin exists in the blood in two conditions of oxidation, which are designated by the names oxyhæmoglobin and reduced hæmoglobin. The latter contains the less quantity of oxygen, and preponderates in venous blood. As the blood circulates in the lung, its hæmoglobin takes up oxygen from the air, in the air vesicles, to form oxyhæmoglobin, in which the oxygen is held in an easily decomposable chemical combination.

1110. *What changes does oxyhæmoglobin undergo in the capillary circulation, and what is its function?*

The opposite change occurs to that which takes place in the pulmonary circulation. The oxyhæmoglobin is decomposed; oxygen passes into the tissues, and reduced hæmoglobin returns by the venous system to the lungs to receive a fresh supply of oxygen. The coloring matter is, therefore, the carrier of oxygen from the air to the tissues.

1111. *How may the two conditions of hæmoglobin be distinguished by the spectroscope?*

Solutions of oxyhæmoglobin present two absorption bands, between the solar lines D and E. That nearer D being narrower, sharper, and darker than that nearer E. Solutions of reduced hæmoglobin, on the other hand, show a single broad band, occupying about the space left bright between the oxyhæmoglobin bands, and more faint and ill-defined than either of those.

1112. *What action has carbon monoxid on oxy-hæmoglobin?*

It drives out all of the oxygen, and forms, with the reduced hæmoglobin, a compound which is more stable than oxyhæmoglobin, and from which the carbon monoxid cannot be again displaced by oxygen.

1113. *What is hæmatin?*

An uncrystallizable coloring matter formed by the decomposition of hæmoglobin.

1114. *How may hæmoglobin be detected in the urine?*

1. By spectroscopic examination (see Q. 1110).
2. To a few drops of the urine in a test tube add a drop of a freshly prepared tincture of guaiacum and a little ozonic ether (or turpentine), and shake; a blue color is produced.

1115. *What peculiar albuminoid substance exists in milk, and what are its properties?*

Casein. An amorphous, white substance, tasteless and odorless, very soluble in alkaline fluids. Coagulates with acids, and under the influence of infusion of *rennet* (mucous membrane of fourth stomach of calf), but not by heat.

1116. *Whence is gelatin obtained, and how?*

From bones, tendons, fish bladders, skins, etc. These tissues contain a peculiar substance, called collagen, in combination with mineral and other matters. When collagen is heated with water, under such pressure that the temperature reaches 106° ($222^{\circ}.8$ F.), a solution is formed which, on cooling, solidifies to a jelly. This jelly contains a new substance, gelatin, glue, isinglass, or size, according to the substances used and the peculiarities of the manufacturing process followed.

1117. *What are the toxalbumens?*

Substances of albuminoid nature and possessed of poisonous qualities. A few are of vegetable origin, as abrin, the poisonous constituent of jequirity, but most are products of bacterial action, pathogenic or putrefactive.

(See Manual, pp. 477-489.)

ANIMAL CRYPTOLYTES, OR FERMENTS.

1118. *What are the characters of substances of this class?*

They are nitrogenized bodies, in some respects resembling the albuminoids, which have the power to provoke changes in other organic substances in some way as yet imperfectly understood.

1119. *What cryptolyte exists in the saliva, and what is its action?*

Ptyalin. It has the property of changing starch into sugar in a liquid of alkaline reaction.

1120. *What cryptolyte exists in the gastric juice, and what is its principal action?*

Pepsin. In the presence of a free acid (best HCl) it converts albuminous substances into albuminose.

1121. *What cryptolytes exist in the pancreatic secretion, and what are their actions?*

1. Trypsin, which converts albuminous substances into albuminose in alkaline liquids. 2. A diastatic cryptolyte, converting starch into maltose and glucose. 3. Some substance capable of emulsifying and saponifying the fats,

ANIMAL COLORING MATTERS.

(For blood-coloring matter see Q. 1104-1114.)

1122. *Name the principal coloring matters of the bile.*

Bilirubin and biliverdin.

1123. *State the properties of bilirubin.*

It forms microscopic, orange or brick-red crystals, soluble in chloroform or benzene, insoluble in water, ether, alcohol, and dilute acid, soluble in dilute alkalies. When acted upon by oxidizing agents, it is converted into biliverdin.

1124. *Describe Gmelin's reaction for bile pigments as applied to the urine.*

Put 3 c.c. HNO_3 in a test tube, add a piece of wood, and heat until the acid is yellow; cool. When cold, float some of the urine to be tested upon the surface of the acid. A green band is formed at the junction of the liquids, which gradually rises, and is succeeded from below by blue, reddish-violet, and yellow.

1125. *How should urine be examined for color?*

It should be acidulated with HCl , and allowed to stand for four hours, after which it should be placed in a beaker of about three inches diameter, and the color observed by transmitted light.

1126. *Describe how the color may vary physiologically.*

The greater the quantity of urine voided, the lighter the color, as a rule. The morning urine is darker than that voided at other times. The use of animal food also produces a high colored urine. The use of certain drugs communicates peculiar colors to the urine; rhubarb, bright yel-

low ; senna, brownish ; logwood, reddish ; santonin, orange-red or golden-yellow.

1127. *Under what pathological conditions is the urine pale?*

Under those conditions which produce an increase in the quantity, and in anæmia. In the latter condition the quantity is not increased.

1128. *Under what conditions is it high-colored?*

Under those conditions in which the quantity of water eliminated by the kidneys is diminished, while the elimination of the solids remains normal or is increased. Such urines have a high specific gravity, and are strongly acid. As the coloring matter of the urine is a product of the disassimilation of hæmoglobin, an absolute increase in the quantity of urine pigment eliminated indicates an increased destruction of blood corpuscles.

NOTE.—A comparatively light-colored urine is frequently found, on addition of acid, to contain a large quantity of coloring matter, which, before the action of the acid, was in the form of a colorless combination.

1129. *To what do brown and black urines owe their color?*

To the presence of abnormal coloring matters, blood, or bile.



APPENDIX.

A.

ELEMENTS.

Aluminium.....	Al.....	27
Antimony.....	Sb.....	120
Arsenic.....	As.....	74.9
Barium.....	Ba.....	136.8
Bismuth.....	Bi.....	206.5
Boron.....	B.....	11
Bromine.....	Br.....	80
Cadmium.....	Cd.....	111.8
Cæsium.....	Cs.....	132.6
Calcium.....	Ca.....	40
Carbon.....	C.....	12
Cerium.....	Ce.....	141
Chlorine.....	Cl.....	35.5
Chromium.....	Cr.....	52.4
Cobalt.....	Co.....	58.9
Columbium.....	Cb.....	94
Copper.....	Cu.....	63.2
Davyium.....	Da.....	154
Didymium.....	D.....	144.8
Erbium.....	E.....	165.9
Fluorine.....	F.....	19
Gallium.....	Ga.....	68.8
Germanium.....	Gr.....	72.3
Glucinum.....	Gl.....	9
Gold.....	Au.....	196.2
Hydrogen.....	H.....	1
Indium.....	In.....	113.4
Iodin.....	I.....	126.9
Iridium.....	Ir.....	192.7

Iron	Fe	55.9
Lanthanium.....	La.....	138.5
Lead	Pb.....	206.9
Lithium.....	Li	7
Magnesium	Mg.....	24
Manganese	Mn.....	54
Mercury.....	Hg.....	199.7
Molybdenum.....	Mo.....	95.5
Nickel.....	Ni	58
Nitrogen.....	N	14
Osmium.....	Os.....	198.5
Oxygen.....	O	16
Palladium.....	Pd	105.7
Phosphorus	P	31
Platinum	Pt	194.4
Potassium.....	K	39.1
Rhodium.....	Rh.....	104.1
Rubidium	Rb.....	85.3
Ruthenium	Ru.....	104.2
Samarium	Sm.....	150
Scandium.....	Sc.....	44
Selenium.....	Se	78.9
Silicon	Si.....	28
Silver	Ag.....	107.7
Sodium	Na.....	23
Strontium.....	Sr.....	87.4
Sulfur	S	32
Tantalum	Ta.....	182
Tellurium.....	Te.....	128
Thallium.....	Tl	208.7
Thorium.....	Th.....	233
Tin.....	Sn.....	117.7
Titanium	Ti.....	49.9
Tungsten	W.....	183.6
Uranium.....	U	238.5
Vanadium.....	V	51.3
Ytterbium.....	Yb.....	172.7
Yttrium.....	Y	89.8
Zinc	Zn.....	64.9
Zirconium.....	Zr.....	89.6

B.

MEASURES AND WEIGHTS.

I.

Measures of length.

1 Kilometre = 1000 metres:	1 Millimetre = 0.001 metre.
1 Hectometre = 100 "	1 Centimetre = 0.01 "
1 Decametre = 10 "	1 Decimetre = 0.1 "

1 METRE = Unity.

1 Kilometre = 0.6214 mile.	1 Centimetre = 0.3937 inch.
1 Metre = 3.2809 feet.	1 Millimetre = 0.0394 "

1 Foot = 30.48 centimetres. | 1 inch = 2.54 centimetres.

Weights.

1 Kilogram = 1000 grams.	1 Milligram = 0.001 gram.
1 Hectogram = 100 "	1 Centigram = 0.01 "
1 Decagram = 10 "	1 Decigram = 0.1 "

1 Gram.

1 Kilogram = 2.679 lbs. Troy. | 1 Gram. = 15.434 grains.

1 Grain = 0.065 gram.	1 Dram = 3.888 grams.
1 Scruple = 1.296 grams.	1 Ounce = 31.103 "
1 Pound = 873.19 grams.	

Measures of volume.

1 Cubic metre = 1000 litres.

1 Cubic centimetre = 0.001 litre.

1 Litre = 1 cubic decimetre.

1 Litre = 1.0567 quarts.	1 c.c. = 0.061 cubic inch.
1 Minim = 0.0614 c.c.	1 Fluid ounce = 29.513 c.c.
1 Fluid dram = 3.689 "	1 Pint = 472.208 "

To convert thermometric scales.

Centigrade into Fahrenheit:

$$\frac{\text{Cent.} \times 9}{5} + 32 = \text{Fah.}$$

Fahrenheit into Centigrade;

$$\frac{\text{Fah.} - 32}{9} \times 5 = \text{Cent.}$$

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